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# Environmental Assessment of NOx Control on a Spark-Ignited Large Bore Reciprocating Internal Combustion Engine. Volume 2 Data Supplement

Acurex Corp., Mountain View, CA

Prepared for

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Research Triangle Park, NC

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January 1986

# ENVIRONMENTAL ASSESSMENT OF $NO_x$ CONTROL ON A SPARK-IGNITED LARGE BORE RECIPROCATING INTERNAL COMBUSTION ENGINE

## Volume II
## Data Supplement

by

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Contract No. 68-02-3188

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16. ABSTRACT

Volume II of this report is a compendium of detailed emission and test data from field tests of a large-bore, spark-ignited reciprocating engine and laboratory analyses of collected samples. The engine was tested in two operating modes: a baseline (normal) operation, and with increased air/fuel ratio for NOx reduction to levels below the proposed new source performance standard (NSPS) of 700 ppm dry at 15 percent $O_2$. The test data include preliminary equipment calibration, detailed engine operation, and complete exhaust gas emission measurement results. Exhaust gas emission measurements included (in addition to continuous monitoring for criteria gas pollutants) monitoring for volatile hydrocarbons ($C_1$-$C_6$), total organics in two boiling point ranges, organic compound category information, specific quantitation of the semivolatile organic priority pollutants, separation of organic extracts, exhaust gas concentration of trace elements, and biological assays of organic sample extracts.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group | |
|---|---|---|---|---|
| Pollution | Combustion Control | Pollution Control | 13B | |
| Diesel Engines | Stoichiometry | Stationary Sources | 21G | 07D |
| Spark-Ignition | Field Tests | Environmental Assessment | 21B | |
| Nitrogen Oxides | | | 07B | |
| Assessments | | Combustion Modification | 14B | |
| Exhaust Gases | | | | |

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# SECTION 1

# INTRODUCTION

The purpose of this Data Supplement is to document data in greater detail than was practical in the technical report for this field test.* It is intended to provide sufficient detail for researchers to perform their own analysis of the data obtained. Readers are referred to the technical report for objectives, description of the source emission results, interpretation, and conclusions. The data supplement contains the following information in corresponding sections:

- Section 2: Preliminary Equipment Calibration and Tests -- Calibration data for the dry gas meters used to sample exhaust gas for both EPA Method 5 and Source Assessment Sampling System (SASS) trains. Exhaust gas velocity traverse data across exhaust duct.
- Section 3: Engine Operating Data -- Complete operating data of test engine, including fuel and air flow, power output, and inlet and exhaust temperatures. Data recorded by engine operators (employees of Colt Industries).
- Section 4: Sampling Data Sheets -- Emission data obtained with continuous monitoring instrumentation. Operating data tables for

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*Castaldini, C. "Environmental Assessment of $NO_x$ Control on a Spark Ignited Large Bore Reciprocating Internal Combustion Engine -- Volume I: Technical Results," EPA-600/7-86-002a, January 1986.

EPA Method 5 (for particulate mass emissions), and Source Assessment Sampling System (for particulate, trace element, and organic sampling).

- Section 5: Analytical Laboratory Results -- Ultimate analysis of lube oil and gas chromatography analysis of natural gas used in the engine. Laboratory analysis reports on particulate emissions by gravimetric analysis; trace element emissions by Spark Source Mass Spectrometry (SSMS) and Atomic Absorption Spectrometry (AAS) analyses; total chromatographable organic (TCO) and gravimetry (GRAV) results, with IR spectra of total sample extracts; determination of organic compounds by gas chromatography/mass spectrometry (GC/MS); liquid chromatography separation of selected sample extracts, with TCO, GRAV, and IR analyses of LC fractions; low resolution spectrometry of LC fractions; and biological assays of the XAD-2 extract samples for both baseline and controlled $NO_x$ tests.

# SECTION 2

# PRELIMINARY EQUIPMENT CALIBRATION AND TESTS

## PITOT TUBE CORRECTION FACTOR AND CALIBRATION DATA

Probe Description:

Pitot Tube Type: S TYPE

Identification No.: #4 07 [illegible]

Calibration Date: 4/7/80

Calibrated By: ERIC AYNSLEY

## WIND TUNNEL SPECIFICATIONS

Type: Plexiglass (Round)

Inside Diameter: 12 inches

Length: 10 feet

Port Locations: 8 feet downstream

Cp std = .99 70°

### "A" SIDE CALIBRATION

| RUN NO. | $\Delta p_{std}$ (IN. $H_2O$) | $\Delta p_{(s)}$ (IN. $H_2O$) | $Cp_{(s)}$ | DEV. |
|---|---|---|---|---|
| 1 | 0.16<br>0.17 | 0.22<br>0.24 | 0.8442<br>0.8532 | |
| 2 | 0.42<br>0.41 | 0.51<br>0.56 | 0.8353<br>0.8471 | |
| 3 | 0.78<br>0.78 | 1.08<br>1.06 | 0.8413<br>0.8492 | |
| | | AVERAGE | .842 | |

### "B" SIDE CALIBRATION

| RUN NO. | $\Delta p_{std}$ (IN. $H_2O$) | $\Delta p_{(s)}$ (IN. $H_2O$) | $Cp_{(s)}$ | DEV. |
|---|---|---|---|---|
| 1 | 0.15<br>0.16 | 0.21<br>0.23 | 0.8[illegible]7<br>0.8[illegible]57 | |
| 2 | 0.37<br>0.40 | 0.54<br>0.55 | 0.84[illegible]<br>0.8[illegible] | |
| 3 | 0.81<br>0.80 | 1.08<br>1.09 | 0.8[illegible]4<br>0.8481 | |
| | | AVERAGE | .840 | |

"A" Side Average Deviation =
"B" Side Average Deviation = Must be ≤ 0.01

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## PITOT TUBE CORRECTION FACTOR AND CALIBRATION DATA

Probe Description: /

Pitot Tube Type: S TYPE

Identification No.: #3 11 'A' side numbered

Calibration Date: 4/17/80

Calibrated By: ERIC AYNSLEY

## WIND TUNNEL SPECIFICATIONS

Type: Plexiglass (Round)

Inside Diameter: 12 inches

Length: 10 feet

Port Locations: 8 feet downstream

Cp std = .99 70°

"A" SIDE CALIBRATION

| RUN NO. | ΔPstd (IN. $H_2O$) | Δp (s) (IN. $H_2O$) | Cp (s) | DEV. |
|---|---|---|---|---|
| 1 | 0.11<br>0.11 | 0.15<br>0.16 | 0.8477<br>0.8209 | |
| 2 | 0.39<br>0.39 | 0.54<br>0.55 | 0.8413<br>0.8537 | |
| 3 | 0.79<br>0.78 | 1.11<br>1.06 | 0.8332<br>0.8492. | |
| | | AVERAGE | 0.838 | |

"B" SIDE CALIBRATION

| RUN NO. | ΔPstd (IN. $H_2O$) | Δp (s) (IN. $H_2O$) | Cp (s) | DEV. |
|---|---|---|---|---|
| 1 | 0.12<br>0.11 | 0.17<br>0.15 | 0.8517<br>0.8477 | |
| 2 | 0.39<br>0.41 | 0.55<br>0.57 | 0.8357<br>0.8396 | |
| 2 | 0.81<br>0.79 | 1.10<br>1.10 | 0.8495<br>0.8390 | |
| | | AVERAGE | 0.840 | |

"A" Side Average Deviation =
"B" Side Average Deviation = Must be ≤ 0.01

# THE ALMEGA CORPORATION

## PITOT TUBE CORRECTION FACTOR AND CALIBRATION DATA

Probe Description:

Pitot Tube Type: S TYPE

Identification No.: #1 #50 Mainokom Bríd –

Calibration Date: 4/17/80

Calibrated By: ERIC AYNSLSY

### WIND TUNNEL SPECIFICATIONS

Type: Plexiglass (Round)

Inside Diameter: 12 inches

Length: 10 feet

Port Locations: 8 feet downstream

Cp std = .99 @ 70°

| | | "A" SIDE CALIBRATION | | |
|---|---|---|---|---|
| RUN NO. | Δp std (IN. $H_2O$) | Δp (s) (IN. $H_2O$) | Cp (s) | DEV. |
| 1 | 0·08<br>0·08 | 0·11<br>0·11 | 0·8443<br>0·8443 | |
| 2 | 0·41<br>0·42 | 0·57<br>0·58 | 0·8376<br>0·8425 | |
| 3 | 0·79<br>0·78 | 1·11<br>1·08 | 0·8352<br>0·8413 | |
| | | AVERAGE | .841 | |

| | | "B" SIDE CALIBRATION | | |
|---|---|---|---|---|
| RUN NO. | Δp std (IN. $H_2O$) | Δp (s) (IN. $H_2O$) | Cp (s) | DEV. |
| 1 | 0·08<br>0·11 | 0·11<br>0·15 | 0·8443<br>0·8447 | |
| 2 | 0·40<br>0·40 | 0·56<br>0·55 | 0·8367<br>0·8443 | |
| 3 | 0·78<br>0·80 | 1·10<br>1·10 | 0·8337<br>0·8442 | |
| | | AVERAGE | .841 | |

"A" Side Average Deviation =
"B" Side Average Deviation = Must be ≤ 0.01

## PITOT TUBE CORRECTION FACTOR AND CALIBRATION DATA

Probe Description: —

Pitot Tube Type: TYPE

Identification No.: #2 #10 A side

Calibration Date: 4/17/80

Calibrated By: ERIC AYNSLEY

## WIND TUNNEL SPECIFICATIONS

Type: Plexiglass (Round)

Inside Diameter: 12 inches

Length: 10 feet

Port Locations: 8 feet downstream

Cp std = .99 70°

"A" SIDE CALIBRATION

| RUN NO. | $\Delta p_{std}$ (IN. $H_2O$) | $\Delta p_{(s)}$ (IN. $H_2O$) | $Cp_{(s)}$ | DEV. |
|---|---|---|---|---|
| 1 | 0.16<br>0.17 | 0.22<br>0.23 | 0.8442<br>0.8511 | |
| 2 | 0.39<br>0.40 | 0.54<br>0.56 | 0.8413<br>0.8367 | |
| 3 | 0.81<br>0.79 | 1.10<br>1.09 | 0.8495<br>0.8428 | |
| | | AVERAGE | .8443 | |

"B" SIDE CALIBRATION

| RUN NO. | $\Delta p_{std}$ (IN. $H_2O$) | $\Delta p_{(s)}$ (IN. $H_2O$) | $Cp_{(s)}$ | DEV. |
|---|---|---|---|---|
| 1 | 0.15<br>0.15 | 0.21<br>0.21 | 0.8367<br>0.8367 | |
| 2 | 0.42<br>0.41 | 0.58<br>0.58 | 0.8425<br>0.8324 | |
| 3 | 0.81<br>0.80 | 1.11<br>1.10 | 0.8457<br>0.8443 | |
| | | AVERAGE | .837 | |

"A" Side Average Deviation =
"B" Side Average Deviation =

Must be ≤ 0.01

Date 8-27-79
Time
Barometric Pressure 29.91
Ambient Temperature 77

Orifice Meter
Orifice Magnehelic
Primary Calibration Meter
Control Module

Operators
Wet Bulb Temperature

Sm. 187

## METER CALIBRATION DATA

| Orifice Manometer $\Delta H_m$ (in. wg) | Orifice Magnehelic $\Delta H_c$ (in. wg) | Primary Meter $\Delta P_p$ (in. wg) | Dry Test Meter $P_{dg}$ (in. wg) | Gas Volume Primary Meter $V_p$ (ft³) | Gas Volume Dry Test Meter $V_d$ (ft³) | Temperature: Primary Meter Inlet, $T_{pi}$ (°F) | Outlet, $T_{po}$ (°F) | Avg., $T_{pa}$ (°F) | Dry Test Meter Inlet, $T_{di}$ (°F) | Outlet, $T_{do}$ (°F) | Avg., $T_{da}$ (°F) | Time t (min.) | α | $K_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .80 | .8 | | | 444.890<br>434.978 | 269.758<br>259.758 | 78<br>78 | 78<br>79 | 78.25 | 77<br>79 | 78<br>78 | 78 | 14.4 | 1.011 | 1.380 |
| | | | | 9.912 | 10.000 | | | | | | | | | |
| 1.80 | 1.8 | | | 454.866<br>444.890 | 279.758<br>269.758 | 76<br>76 | 77<br>78 | 76.75 | 75<br>76 | 76<br>76 | 75.75 | 13.5 | 1.001 | 1.429 |
| | | | | 9.970 | 10.000 | | | | | | | | | |
| 2.82 | 2.8 | | | 464.860<br>454.860 | 289.758<br>279.758 | 77<br>77 | 77<br>78 | 77.75 | 78<br>81 | 76<br>77 | 78 | 10.9 | 1.008 | 1.437 |
| | | | | 10.000 | 10.000 | | | | | | | | | |
| 3.85 | 3.8 | | | 478.137<br>468.111 | 303.000<br>293.000 | 79<br>79 | 79<br>80 | 79.25 | 81<br>83 | 79<br>79 | 80.5 | 9.4 | 1.004 | 1.444 |
| | | | | 10.026 | 10.000 | | | | | | | | | |
| | | | | | | | | | | | | Average | | |

α avg = 1.005

$K_o$ avg = 1.423

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Date 1/30/[illegible]
Time 0[illegible]2[illegible]
Barometric Pressure 3[illegible] [illegible]
Ambient Temperature 6[illegible]

Orifice Meter
Orifice Magnehelic 8117WW38
Primary Calibration Meter 26[illegible]453
Control Module 520-088

Operators JARMAN
Wet Bulb Temperature

METER CALIBRATION DATA  Orifice plate # 060

| Orifice Manometer $\Delta H_{ref}$ (in wg.) | Orifice Magnehelic $\Delta H_O$ (in wg.) | Primary Meter $\Delta H_p$ (in wg.) | Dry Test Meter $P_{dt}$ (in wg.) | Gas Volume Primary Meter $V_p$ (ft.³) | Gas Volume Dry Test Meter $V_d$ (ft.³) | Temperature: Primary Meter Inlet $T_{pi}$ (°F) | Primary Meter Outlet $T_{po}$ (°F) | Primary Meter Avg. $T_{pa}$ (°F) | Dry Test Meter Inlet $T_{di}$ (°F) | Dry Test Meter Outlet $T_{do}$ (°F) | Dry Test Meter Avg. $T_{da}$ (°F) | Time θ (min.) | γ | $K_O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .69 | .6 | | | 935.151<br>920.700 | 143.845<br>129.785 | 66<br>66 | 64<br>65 | 65.25 | 63<br>64 | 64<br>63 | 63.5 | 34.0 | 1.001 | .710 |
| | | | | 14.451 | 14.06 | | | | | | | | | |
| 1.6 | 1.6 | | | 950.084<br>935.151 | 158.255<br>143.845 | 66<br>65 | 65<br>65 | 65.25 | 64<br>65 | 64<br>64 | 64.25 | 21.0 | 1.013 | .727 |
| | | | | 14.933 | 14.410 | | | | | | | | | |
| 2.6 | 2.6 | | | 965.232<br>950.151 | 173.032<br>158.255 | 64<br>73 | 65<br>67 | 67.25 | 65<br>65 | [illegible] | 65.75 | 17.0 | [illegible] | .710 |
| | 1.2 | | | 15.081 | 14.777 | | | | | | | | | |
| 3.6[illegible] | 3.6 | | | [illegible]<br>965.232 | [illegible]<br>173.032 | [illegible]<br>7[illegible] | 67<br>68 | 70.25 | 65<br>66 | 65<br>[illegible] | 65.[illegible] | 15.0 | [illegible] | .711 |
| | | | | 15.653 | 15.1[illegible] | | | | | | | | | |
| .69 | .6 | | | 996.188<br>981.137 | 207.061<br>192.[illegible] | 69<br>[illegible] | 65<br>[illegible] | [illegible] | 65<br>66 | 65<br>66 | 65.50 | 14.0 | 1.031 | 1.293 |
| | | | | 15.051 | 14.668 | | | | | | | | | |
| 1.6 | 1.6 | | | 1011.554<br>996.188 | 218.205<br>203.061 | 67<br>[illegible] | 68<br>68 | 67.75 | 66<br>66 | 66<br>66 | 66.0 | 9.0 | [illegible] | 1.743 |
| | 2.4 | | | 15.366 | 15.144 | | | | | | | | | |
| 2.61 | 2.6 | | | 26.909<br>11.554 | 233.273<br>218.205 | 73<br>82 | 69<br>72 | 74.0 | 67<br>67 | 66<br>66 | 66.5 | 7.0 | [illegible] | 1.756 |
| | 2.8 | | | 15.355 | 15.068 | | | | | | | | | |
| 3.6 | 3.6 | | | 44.832<br>26.909 | 250.828<br>233.273 | 78<br>84 | 70<br>72 | 76.0 | 67<br>68 | 67<br>67 | 67.25 | 7.0 | 1.116 | 1.741 |
| | 3.2 | | | 17.923 | 17.555 | | | | | | | | | |
| .59 | .6 | | | [illegible].737<br>44.832 | [illegible]<br>250.828 | 75<br>81 | 71<br>72 | 74.75 | 68<br>69 | 67<br>68 | 68.0 | 7.0 | 1.083 | 3.781 |
| | 3.6 | | | 15.905 | 15.665 | | | | | | | | | |
| 1.6 | 1.6 | | | 74.914<br>60.727 | 276.515<br>266.498 | 81<br>89 | 72<br>74 | 79.0 | 69<br>70 | 68<br>66 | 68.25 | 4.0 | 1.151 | [illegible].611 |
| | 4.0 | | | 14.177 | 14.037 | | | | | | | | | |
| 2.62 | 2.6 | | | 92.659<br>74.914 | 297.857<br>280.515 | 87<br>92 | 74<br>77 | 82.75 | 70<br>71 | 68<br>68 | 69.25 | 4.0 | 1.196 | 3.543 |
| | 4.4 | | | 17.745 | 17.744 | | | | | | | | | |
| 3.6 | 3.6 | | | 107.791<br>92.659 | 313.557<br>298.257 | 90<br>94 | 77<br>78 | 84.75 | 71<br>71 | 68<br>69 | 69.75 | 3.0 | 1.239 | [illegible]4 21 |
| | 4.8 | | | 15.132 | 15.298 | | | | | | | | | |
| | 5.0 | | | | | | | | | | | | | |

| Average | |
|---|---|
| | |

A-21 [illegible]

K₀ - .714

α - 1.0[illegible]

K₀ - 1.75[illegible]

α - 1.09[illegible]

α - 1166

K₀ - 3.585

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Date 4/18/80
Time 11:00
Barometric Pressure 29.75
Ambient Temperature 72°F

Orifice Meter
Orifice Magnehelic 4E7250B21
Primary Calibration Meter 259453
Control Module 0016

Operators Rehder
Kaufman
Miceli
Wet Bulb Temperature

Orifice Plate # 0009

METER CALIBRATION DATA

| Orifice Manometer $\Delta H_{ref}$ (in.wg.) | Orifice Magnehelic $\Delta H_O$ (in.wg.) | Primary Meter $\Delta H_p$ (in.wg.) | Dry Test Meter $P_{dg}$ (in. wg.) | Gas Volume Primary Meter $V_p$ (ft.³) | Gas Volume Dry Test Meter $V_d$ (ft.³) | Temperature: Primary Meter Inlet, $T_{pi}$ (°F) | Outlet, $T_{po}$ (°F) | Avg., $T_{pa}$ (°F) | Temperature: Dry Test Meter Inlet, $T_{di}$ (°F) | Outlet, $T_{do}$ (°F) | Avg., $T_{da}$ (°F) | Time t (min.) | γ | $K_O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 0.6<br>0.4 |  |  | 968.107<br>955.594<br>12.513 | 826.451<br>814.100<br>12.351 | 83<br>84 | 84<br>83 | 83.5 | 79<br>~~83~~ 79 | 79<br>79 | 79 | 28 | .997 | .734 |
|  | 1.6<br>0.8 |  |  | 978.542<br>968.107<br>10.435 | 836.643<br>826.451<br>10.192 | 84<br>87 | 83<br>84 | 84.5 | 77<br>80 | 79<br>79 | 79 | 15 | .991 | .686 |
|  | 2.6<br>1.2 |  |  | 993.301<br>978.542<br>14.759 | 851.073<br>836.643<br>14.430 | 87<br>89 | 84<br>85 | 86 | 80<br>80 | 79<br>80 | 80 | 17 | .996 | .680 |
|  | 3.6<br>1.6 |  |  | 1006.400<br>993.301<br>13.097 | 863.708<br>851.073<br>12.315 | 87<br>88 | 85<br>84 | 85 | 80<br>80 | 80<br>80 | 80 | 13 | .996 | .671 |
|  | .6<br>2.0 |  |  | 1021.771<br>1006.400<br>15.371 | 878.752<br>863.708<br>15.044 | 85<br>85 | 85<br>84 | 86 | 80<br>79 | 80<br>77 | 79.5 | 13 | .992 | .939 |
|  | 1.6<br>2.4 |  |  | 1037.515<br>1021.771<br>15.744 | 894.382<br>878.952<br>15.430 | 85<br>93 | 85<br>86 | 85 | 80<br>80 | 80<br>80 | 80 | 9 | .999 | 1.748 |
|  | 2.6<br>2.8 |  |  | 1055.312<br>1037.515<br>17.797 | 911.777<br>894.382<br>17.395 | 95<br>102 | 87<br>88 | 93 | 80<br>80 | 80<br>80 | 80 | 8 | 1.007 | 1.744 |
|  | 3.6<br>3.2 |  |  | 1065.658<br>1055.312<br>10 346 | 921.884<br>911.777<br>10 107 | 101<br>105 | 89<br>90 | 96 | 80<br>81 | 80<br>80 | 80 | 4 | 1.015 | 1.723 |
|  | 3.4 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 1.6<br>3.8 |  |  | 1088.974<br>1077.237<br>[illegible].737 | [illegible]<br>[illegible]<br>10.[illegible]3 | 101<br>102 | 90<br>91 | 96 | 81<br>81 | 81<br>81 | 81 | 3 | [illegible] | [illegible] |
| 3 | 2.6<br>4.2 |  |  | 1103.318<br>1088.974<br>14.344 | 958.848<br>944.723<br>14.125 | 104<br>105 | 92<br>97 | 99 | 81<br>82 | 81<br>81 | 81 | 3.5 | [illegible] | [illegible] |
| 1 | .6<br>4.6 |  |  | 1077.237<br>1065.658<br>11.579 | 933.185<br>921.881<br>11.304 | 99<br>102 | 89<br>90 | 95 | 81<br>81 | 80<br>80 | 80.5 | 5 | 1.009 | 3.716 |
| 4 | 3.6<br>5.0 |  |  | 1113.626<br>1103.318<br>[illegible].308 | 969.061<br>958.848<br>10.213 | 109<br>110 | 94<br>96 | 102 | 83<br>82 | 82<br>81 | 82 | 2 | 1.035 | 3.427 |

|  |  |
|---|---|
| Average |  |
|  |  |

.86

281

258

α .995
K0 .694

α 1.003
K0 1.786

α 1.020
K0 3.579

Reproduced from best available copy.

Date 4/17/80
Time 1100
Barometric Pressure 29.80
Ambient Temperature 65° F

Orifice Meter 421274
Orifice Magnehelic 00G2 30 H63
Primary Calibration Meter 259453
Control Module 0038

Operators Kaufmann
Wet Bulb Temperature

orifice plate # 0038

## METER CALIBRATION DATA

| Orifice Manometer $\Delta H_{ref}$ (in.wg.) | Orifice Magnehelic $\Delta H_@$ (in.wg.) | Primary Meter $\Delta H_p$ (in.wg.) | Dry Test Meter $P_{dg}$ (in. wg.) | Gas Volume Primary Meter $V_p$ (ft.³) | Gas Volume Dry Test Meter $V_d$ (ft.³) | Temperature: Primary Meter Inlet, $T_{pi}$ (°F) | Primary Meter Outlet, $T_{po}$ (°F) | Primary Meter Avg., $T_{pa}$ (°F) | Dry Test Meter Inlet, $T_{di}$ (°F) | Dry Test Meter Outlet, $T_{do}$ (°F) | Dry Test Meter Avg., $T_{da}$ (°F) | Time t (min.) | α | $K_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | .6 | | | 492.198<br>482.200 | 556.948<br>547.043 | 67<br>68 | 66<br>67 | 67 | 67<br>67 | 65<br>67 | 67 | 20. | .997 | .764 |
| | 0.4 | | | 9.998 | 9.905 | | | | | | | | | |
| | 1.6 | | | [illegible].365<br>492.198 | 567.601<br>556.948 | 69<br>72 | 67<br>68 | 69 | 68<br>68 | 67<br>67 | 68 | 15 | .998 | .739 |
| | 0.8 | | | 10.787 | 10.653 | | | | | | | | | |
| | 2.6 | | | 516.613<br>502.985 | 581.071<br>567.601 | 73<br>76 | 68<br>69 | 72 | 69<br>69 | 68<br>68 | 69 | 15 | 1.009 | .732 |
| | 1.2 | | | 13.628 | 13.464 | | | | | | | | | |
| | 3.6 | | | 532.563<br>516.613 | 596.806<br>581.071 | 77<br>82 | 70<br>73 | 75 | 69<br>70 | 68<br>69 | 69 | 15 | 1.007 | .728 |
| | 1.6 | | | 15.950 | 15.735 | | | | | | | | | |
| | .6 | | | 551.730<br>532.563 | 615.779<br>596.807 | 70<br>75 | 70<br>70 | 71 | 70<br>70 | 70<br>70 | 70 | 7 | .993 | 1.85 |
| | 2.0 | | | 19.168 | 18.972 | | | | | | | | | |
| | 1.6 | | | 585.462<br>551.730 | 649.138<br>615.719 | 81<br>92 | 78<br>75 | 82 | 70<br>71 | 70<br>71 | 71 | 16 | [redacted] | 1.889 |
| | 2.4 | | | 33.731 | 33.419 | | | | | | | | | |
| | 2.6 | | | 609.114<br>585.462 | 672.394<br>649.138 | 88<br>95 | 76<br>78 | 84 | 72<br>73 | 71<br>71 | 72 | 10 | .999 | 1.868 |
| | 2.8 | | | 23.652 | 23.256 | | | | | | | | | |
| | 3.6 | | | 628.133<br>609.114 | 691.314<br>672.394 | 73<br>82 | 73<br>74 | 76 | 70<br>71 | 70<br>71 | 71 | 7 | 1.013 | 1.836 |
| | 3.2 | | | 19.019 | 18.920 | | | | | | | | | |
| | .6 | | | 654.672<br>628.133 | 717.515<br>691.314 | 80<br>88 | 74<br>76 | 80 | 71<br>72 | 71<br>71 | 71 | 11 | 1.006 | 3.711 |
| | 3.6 | | | 26.539 | 26.201 | | | | | | | | | |
| | 1.6 | | | 680.592<br>654.672 | 743.186<br>717.515 | 84<br>[illegible] | 76<br>80 | 84 | 72<br>74 | 71<br>72 | 72 | 7 | 1.017 | 3.73 |
| | 4.0 | | | 25.920 | 25.671 | | | | | | | | | |
| | 2.6 | | | 703.637<br>680.592 | 766.080<br>743.186 | 94<br>100 | 80<br>83 | 89 | 74<br>76 | 72<br>72 | 74 | 5 | 1.03 | 3.6 |
| | 4.4 | | | 23.045 | 22.894 | | | | | | | | | |
| | 3.6 | | | 730.086<br>703.637 | 792.556<br>766.080 | 97<br>103 | 83<br>86 | 92 | 76<br>78 | 72<br>73 | 75 | 5 | 1.044 | 3.541 |
| | 4.8 | | | 26.449 | 26.476 | | | | | | | | | |
| | 5.0 | | | | | | | | | | | | | |

| Average | |
|---|---|
| | |

α = 0.999
K0 = 0.741

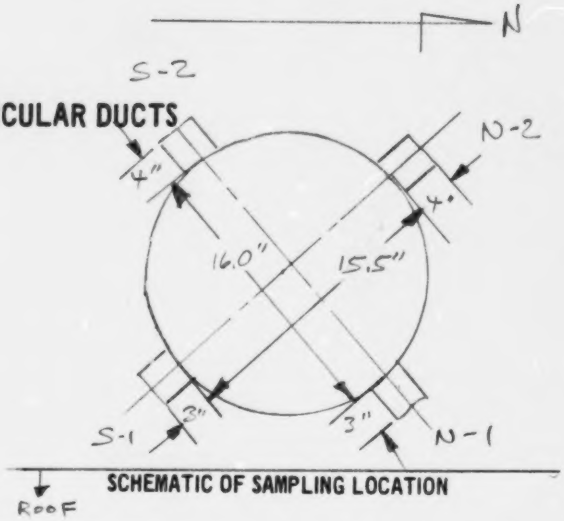
α = 1.005
K0 = 1.860

α 1.024
K0 = 3.719

A-21-81

## TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Colt -- Beloit, WS.
DATE 4-24-80
SAMPLING LOCATION Gas Engine Stack
INSIDE OF FAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE A)
INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE B)
STACK I.D., (DISTANCE A - DISTANCE B) 15.75" avg.
NEAREST UPSTREAM DISTURBANCE
NEAREST DOWNSTREAM DISTURBANCE
CALCULATOR DaRos



SCHEMATIC OF SAMPLING LOCATION

| TRAVERSE POINT NUMBER | FRACTION OF STACK I.D. | STACK I.D. | PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH) | DISTANCE B | TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5) |
|---|---|---|---|---|---|
| 1 | .014 | 15.75 | ~~.221~~ 1.0 | 3.0 | |
| 2 | .044 | | ~~.693~~ 1.0 | | |
| 3 | .075 | | 1.181 | | |
| 4 | .109 | | 1.717 | | |
| 5 | .146 | | 2.300 | | |
| 6 | .188 | | 2.961 | | |
| 7 | .236 | | 3.717 | | |
| 8 | .296 | | 4.662 | | |
| 9 | .382 | | 6.017 | | |
| 10 | .618 | | 9.734 | | |
| 11 | .704 | | 11.088 | | |
| 12 | .764 | | 12.033 | | |
| 13 | .812 | | 12.789 | | |
| 14 | .854 | | 13.451 | | |
| 15 | .891 | | 14.033 | | |
| 16 | .925 | | 14.569 | | |
| 17 | .956 | | ~~15.057~~ 14.75 | | |
| 18 | .986 | 15.75 | ~~15.530~~ 14.75 | 3.0 | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

EPA (Dur) 232
4/72

# PRELIMINARY VELOCITY TRAVERSE

PLANT Colt -- Beloit, WS
DATE 4-25-80
LOCATION Gas Engine Stack - Controlled
STACK I.D. 15.75" avg.
BAROMETRIC PRESSURE, in. Hg 29.15" @0830
STACK GAUGE PRESSURE, in. $H_2O$ +1.0
OPERATORS Kaufmann, Rehder
START: 0900 STOP: 0925

SAME AS 4-24-80
DATA
(GAS ENGINE STACK)

SCHEMATIC OF TRAVERSE POINT LAYOUT

PORT N-1

| TRAVERSE POINT NUMBER | VELOCITY HEAD ($\Delta p_s$), in. $H_2O$ | STACK TEMPERATURE ($T_s$), °F |
|---|---|---|
| 1 | 2.3 | 570 |
| 2 | 2.3 | 570 |
| 3 | 2.4 | 580 |
| 4 | 2.4 | 575 |
| 5 | 2.5 | 580 |
| 6 | 2.6 | 575 |
| 7 | 2.7 | 580 |
| 8 | 2.7 | 580 |
| 9 | 2.7 | 575 |
| 10 | 2.9 | 587 |
| 11 | 2.8 | 585 |
| 12 | 2.9 | 585 |
| 13 | 2.8 | 585 |
| 14 | 2.8 | 585 |
| 15 | 2.8 | 585 |
| 16 | 2.8 | 585 |
| 17 | 2.8 | 585 |
| 18 | 2.8 | 585 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| AVERAGE | 2.66 | 580.7 |

PORT S-1

| TRAVERSE POINT NUMBER | VELOCITY HEAD ($\Delta p_s$), in. $H_2O$ | STACK TEMPERATURE ($T_s$), °F |
|---|---|---|
| | 2.0 | 545 |
| | 2.0 | 545 |
| | 2.3 | 575 |
| | 2.4 | 585 |
| | 2.5 | 585 |
| | 2.6 | 585 |
| | 2.7 | 585 |
| | 2.7 | 585 |
| | 2.9 | 585 |
| | 2.7 | 585 |
| | 2.8 | 585 |
| | 2.8 | 585 |
| | 2.8 | 585 |
| | 2.6 | 585 |
| | 2.7 | 585 |
| | 2.7 | 583 |
| | 2.7 | 583 |
| | 2.7 | 583 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| AVERAGE | 2.59 | 579.7 |

EPA (Dur) 233
4/72

Ambient Temp 50. °F

Overall Avg. 2.63 580.2

Pitot I.D. #10 .84 = Cp Side A+B

# PRELIMINARY VELOCITY TRAVERSE

PLANT COLT - BELOIT, WS
DATE 4-24-80
LOCATION GAS ENGINE STACK - BASELINE
STACK I.D. 15.75" avg.
BAROMETRIC PRESSURE, in. Hg 29.10 @0900
STACK GAUGE PRESSURE, in. $H_2O$ +1.4"
OPERATORS KAUFMANN, REHDER
START: 12:00N STOP: 1220P

SAME AS 4-24-80
DATA
(GAS ENGINE STACK)

SCHEMATIC OF TRAVERSE POINT LAYOUT

PORT S-1

| TRAVERSE POINT NUMBER | VELOCITY HEAD ($\Delta p_s$), in. $H_2O$ | STACK TEMPERATURE ($T_s$), °F |
|---|---|---|
| 1 | 2.0 | 566 |
| 2 | 2.0 | 570 |
| 3 | 2.0 | 575 |
| 4 | 2.2 | 574 |
| 5 | 2.2 | 580 |
| 6 | 2.4 | 586 |
| 7 | 2.3 | 591 |
| 8 | 2.3 | 592 |
| 9 | 2.3 | 592 |
| 10 | 2.5 | 592 |
| 11 | 2.5 | 592 |
| 12 | 2.6 | 592 |
| 13 | 2.6 | 593 |
| 14 | 2.6 | 593 |
| 15 | 2.6 | 593 |
| 16 | 2.7 | 594 |
| 17 | 2.7 | 594 |
| 18 | 2.7 | 594 |
| | 43.2 | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| AVERAGE | 2.40 | |

PORT N-1

| TRAVERSE POINT NUMBER | VELOCITY HEAD ($\Delta p_s$), in. $H_2O$ | STACK TEMPERATURE ($T_s$), °F |
|---|---|---|
| | 2.0 | 558 |
| | 2.0 | 558 |
| | 2.1 | 562 |
| | 2.2 | 580 |
| | 2.3 | 586 |
| | 2.4 | 587 |
| | 2.5 | 587 |
| | 2.7 | 587 |
| | 2.6 | 591 |
| | 2.4 | 590 |
| | 2.5 | 590 |
| | 2.4 | 590 |
| | 2.5 | 590 |
| | 2.4 | 590 |
| | 2.4 | 590 |
| | 2.3 | 589 |
| | 2.3 | 589 |
| | 2.3 | 589 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| AVERAGE | 2.35 | |

2.4

EPA (Dur) 233
4/72

Ambient Temp = 47°F

Pitot I.D. 10 .84 Cp side A & B

# SECTION 3

# ENGINE OPERATING DATA

Complete engine operating parameters were recorded during the duration of both the baseline and low-$NO_x$ tests. Field data sheets appear in the following. Data for April 24, 1980 correspond to the baseline test; data for April 25, 1980 correspond to the low-$NO_x$ test. Engine operating data reported in Volume 1 represent averages of these values recorded over the duration of the test.

Overall, engine operating conditions varied only slightly over the duration of each test. For example, engine power output changed by less than one percent during each test, while air flowrate varied by 1.5 percent during the baseline test and 2.6 percent during the low-$NO_x$ test. Air temperature at the inlet to the compressor (turbocharger) was maintained artificially at a constant 302°K (85°F). This is the standard inlet combustion air temperature at which $NO_x$ emissions for reciprocating internal combustion engines are reported.

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BF-4173C

Ignition or Injection Timing 3° ATDC
Comp. Ratio 9.75:1
Gas Cam Timing 25° ELIX @ .020 LIFT
Crankled 13° LL
K. W. Mtr. Constant 1260
MOBILGUARD PEGASUS 485
Natural Gas

# TEST LOG
## EXPERIMENTAL DEPT.

LOG NO. 2970
DATE: 4-24-80

TEST: EMISSIONS Spark Baseline
ENGINE W 6 8½ x 10 Turbo Spark ENGINE NO. 889193

POWER PARTS
C. RING Std Prod
LINERS Std Prod
PISTONS Std Prod
SPECIAL Elliot 1158 WITH 0° TWIST TURBINE BLADES & 21° NOZZLE RING & BAFFLES BETWEEN ALL CYL

| | | | ENGINE POWER OUTPUT | | | | | | | | MISCELLANEOUS | | | | ENGINE AIR | | | | ENGINE H. O. | | | ENGINE LUB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Press. | | Temp. | | PSIG | Temp. °F | | Press.-PSIG | | | |
| | | | | | | | | | | | | | | | In HG | In H.O. | °F | °F | | | | | | | |
| Line No. | Time & Shift | Hour Meter Add | RPM | Sec. for 10 Turns (KW) | KW Meter % Reg. | Alt. KW Output | Alt. Eff. % | BHP | % Load | #1 Pump Rack C.S. / O.C.S. | Room Temp. | Corrected Barometer | C. C. Vacuum | Gov. Load Limit | Air Receiver | Blower Suction | Air Inlet | Air Receiver | Pump Disch. | To Engine | From Engine | Pump Disch. | To Strainer | To Engine | Upper Header |
| 1 | 0700-1500 — ORKHKS, START, WARMUP & ON LINE @ 1087 LOAD @ 1010 HRS | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 1012 HRS REMOVE LOAD & STOP — #3 CYL MISFIRING — REMOVED #3 CYL | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | FLAPPERS & #3 CS SPARK PLG. — DISASSEMBLED & CLEANED CS FLAPPER, REPLACED | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | CS SPARK PLUG & REINSTALLED SAME, OCS FLAPPER OK — REINSTALLED — | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 1040 HRS, START & ON LINE 100% — ADDED 41.5 LBS L.O. TO ENGINE — (REMOV | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | CALIBRATED & REINSTALLED #5 CYL PICKUP) | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 1148 | 22.0 | 900 | 42.35 | 98.4 | 1088 | 97.1 | 1502 | 100.1 | | | 29.09 | 2.2 | 5.8 | 8.76 | 7.66 | | 173 | 37 | 169 | 177 | 40 | 30.9 | 29.1 | 23.5 |
| 8 | 1230 | 22.6 | 900 | 42.23 | 98.4 | 1092 | 97.1 | 1506 | 100.4 | | | 29.09 | 1.9 | 5.8 | 8.71 | 7.59 | | 174 | 37 | 169 | 177 | 39.2 | 30.1 | 28.6 | 23.0 |
| 9 | 1300 | 23.2 | 900 | 42.27 | | 1091 | | 1505 | 100.3 | | | 29.09 | 1.6 | 5.7 | 8.73 | 7.62 | | 173 | 37 | 168 | 176 | 39 | 29.8 | 28.3 | 22.8 |
| 10 | 1400 | 24.2 | 900 | 42.44 | | 1086 | | 1499 | 99.9 | | | 29.09 | 2.3 | 5.6 | 8.54 | 7.25 | | 168 | 37 | 169 | 178 | 39 | 29.9 | 28.3 | 22.9 |
| 11 | 1430 | 24.7 | 900 | 42.42 | | 1087 | | 1500 | 100 | | | 29.08 | 2.3 | 5.65 | 8.53 | 7.28 | | 170 | 37 | 169 | 178 | 38.9 | 29.7 | 28.3 | 22.8 |
| 12 | 1500 | 25.2 | 900 | 42.37 | | 1087 | | 1501 | 100.0 | | | 29.08 | 2.5 | 5.60 | 8.50 | 7.25 | | 172 | 37 | 170 | 179 | 38.8 | 29.8 | 28.3 | 22.8 |
| 13 | 1530 | 25.7 | 900 | 42.44 | | 1086 | | 1499 | 99.9 | | | 29.07 | 2.0 | 5.7 | 8.48 | 7.24 | | 171 | 37 | 169 | 179 | 38.8 | 29.8 | 28.3 | 22.9 |
| 14 | 1600 | 26.2 | 900 | 42.62 | | 1081 | | 1493 | 99.5 | | | 29.08 | 2.0 | 5.75 | 8.50 | 7.38 | | 174 | 37 | 169 | 179 | 38.8 | 29.8 | 28.3 | 22.8 |
| 15 | 1630 | 26.7 | 900 | 42.51 | | 1084 | | 1496 | 99.7 | | | 29.08 | 1.6 | 5.9 | 8.70 | 7.50 | | 168 | 37 | 170 | 179 | 38.6 | 29.5 | 28.1 | 22.9 |
| 16 | 1700 | 27.2 | 900 | 42.58 | | 1083 | | 1415 | 99.7 | | | 29.08 | 1.3 | 5.9 | 8.70 | 7.51 | | 168 | 37 | 170 | 179 | 38.4 | 29.2 | 28.0 | 22.5 |
| 17 | 1730 | 27.7 | 900 | 42.57 | | 1082 | | 1494 | 99.6 | | | 29.07 | 1.5 | 5.9 | 8.72 | 7.53 | | 167 | 37 | 170 | 179 | 38.2 | 29.0 | 28.0 | 22.5 |
| 18 | 1800 | 28.2 | 900 | 42.44 | | 1076 | | 1478 | 99.9 | | | 29.08 | 1.1 | 6.0 | 8.72 | 7.63 | | 168 | 37 | 170 | 179 | 38.1 | 29.0 | 28.0 | 22.5 |
| 19 | 1830 | 28.7 | 900 | 42.88 | | 1087 | | 1501 | 100.0 | | | 29.08 | 1.6 | 6.0 | 8.70 | 7.65 | | 168 | 37 | 171 | 180 | 38.0 | 29.0 | 28.0 | 22.2 |
| 20 | | | @ 1830 HRS REMOVED LOAD & STOP | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | |

| E OIL |  |  | FUEL OIL |  |  |  |  |  | NATURAL GAS FUEL |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. °F |  |  | PSIG |  |  |  |  |  | Press. "HG |  | Temp. |  |  |  |  |  |  |  | Press.-PSIG |  |  |  |  |  |
| To Engine | From Engine | Level in C.C. | Fuel Header | Sec. For Lbs. of Fuel | Fuel Cons Lbs./Hr. | Fuel Rate Lbs./BHP-Hr. | Corrected 19350 LB/BHP/HR | Fuel Rate BTU/BHP-Hr. | Meter Inlet | Meter Inlet ABS | Meter Inlet °F | Meter Inlet ABS °B | Sec. for Ft.³ Gas | Ft.³/Hr. @ Std. Temp. & Press. | Gas Heat Value BTU/Ft.³ | Gas Consumption BTU/Hr. x 10³ | Specific Gas Fuel Rate BTU/BHP-Hr. | Total Specific Fuel Rate BTU/BHP-Hr. | Supply To Engine | Cell Hdr. | Engine Hdr. | BYPASS |  | Line No. |
|  |  |  |  |  |  |  |  |  | PSIG | PF |  | F.F | ΔP | QB |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 5 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 6 |
| 165 | 183 | +1 |  |  |  |  |  |  | 71.3 | 85.58 | 74 | 9868 | 26.6 | 12342 | 878 | 10880 | 7244 |  | 51.5 | 37.5/34 | 34.9 | 0 |  | 7 |
| 166 | 184 | +3 |  |  |  |  |  |  | 71.3 | 85.58 | 73 | 9877 | 26.7 | 12427 | 878 | 10911 | 7245 |  | 51.5 | 37.5/34 | 34.9 | 0 |  | 8 |
| 166 | 184 | +2 | ↓ STARTED | TEST ↓ |  |  |  |  | 71.3 | 85.58 | 71 | 9868 | 26.4 | 12346 | 878 | 10839 | 7202 |  | 51.5 | 37.5/34 | 34.7 | 0 |  | 9 |
| 166 | 185 | +1 |  |  |  |  |  |  | 71.4 | 85.68 | 75 | 9859 | 26.4 | 12342 | 878 | 10836 | 7229 |  | 51.5 | 37.5/34 | 34.1 | 0 |  | 10 |
| 166 | 185 | +1 |  |  |  |  |  |  | 71.2 | 85.48 | 75 | 9859 | 26.5 | 12350 | 872.5 | 10775 | 7184 |  | 51.5 | 37/34 | 34.3 | → |  | 11 |
| 167 | 186 | 0 |  |  |  |  |  |  | 71.2 | 85.47 | 76 | 9850 | 26.6 | 12268 | 872 | 10698 | 7127 |  | 51.5 | 37/33 | [illegible] | 16 | 34.5 | 12 |
| 167 | 186 | 0 |  |  |  |  |  |  | 71.2 | 85.47 | 77 | 9840 | 26.5 | 12325 | 872 | 10748 | 7170 |  | 51.5 | 37/34 | [illegible] | 15.8 | 34.0 | 13 |
| 167 | 186 | 0 |  |  |  |  |  |  | 71.2 | 85.47 | 77 | 9840 | 26.9 | 12620 | 871 | 10992 | 7367 |  | 51.5 | 37/33.5 | [illegible] | 15.8 | 34.8 | 14 |
| 168 | 186 | 0 |  |  |  |  |  |  | 71.2 | 85.47 | 77 | 9840 | 26.9 | 12620 | 871 | 10992 | 7342 |  | 51.5 | 37/33 | [illegible] | 16.2 | 34.8 | 15 |
| 168 | 187 | 0 |  |  |  |  |  |  | 71.2 | 85.47 | 78 | 9831 | 27.6 | 12617 | 871 | 10946 | 7322 |  | 51.5 | 36.5/33 | 35.1 | 16.2 |  | 16 |
| 169 | 187 | 0 |  |  |  |  |  |  | 71.2 | 85.41 | 77 | 9840 | 27.6 | [illegible] | 871 | 10926 | 7333 |  | 51.5 | 36.5/33 | 35.1 | 16.8 |  | 17 |
| 169 | 188 | -1 |  |  |  |  |  |  | 71.2 | 85.47 | 76 | 9850 | 27.7 | 12615 | 871 | 10987 | 7334 |  | 51.5 | 36.5/30 | 35.4 | 17.0 |  | 18 |
| 167 | 188 | -2 |  |  |  |  |  |  | 71.2 | 85.41 | 75 | 9859 | 27.7 | 12626 | 871 | 10997 | 7326 |  | 51.5 | 36.5/33 | 35.4 | 17.0 |  | 19 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 20 |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 34 |

| Line No. | TURBO RPM C.S. | TURBO RPM O.C.S. | COMPRESSOR AIR Pressure To Comp. In H2O C.S. | COMPRESSOR AIR Pressure To Comp. In H2O O.C.S. | COMPRESSOR AIR Pressure From Comp. In PSI C.S. | COMPRESSOR AIR Pressure From Comp. In PSI O.C.S. | COMPRESSOR AIR Temp. °F Inlet | COMPRESSOR AIR Temp. °F From Comp. C.S. | COMPRESSOR AIR Temp. °F From Comp. O.C.S. | BLOWER DISCH PSI | BLOWER SUCT °F | BLOWER DISCH °F | WATER Temp. °F From Turbo. C.S. | WATER Temp. °F From Turbo. O.C.S. | WATER Temp. °F Air Cooler In | WATER Temp. °F Air Cooler Out | LUBE OIL PSIG Turbo. Inlet | LUBE OIL Temp. °F From Turbo. C.S. | LUBE OIL Temp. °F From Turbo. O.C.S. | TURBINE EXHAUST Press. "HG To C.S. | TURBINE EXHAUST Press. "HG To O.C.S. | TURBINE EXHAUST Temp. °F To C.S. | TURBINE EXHAUST Temp. °F To O.C.S. | From Turbine | 1 |
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| 6 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 12650 | | 7.1 | | 8.00 | | 86 | 187 | | 9.81 | 135 | 167 | 173 | | 57 | 129 | 30.4 | 191 | | 7.47 | | 792 | | 671 | 775 |
| 8 | 12600 | | 7.1 | | 7.92 | | 88 | 189 | | 9.78 | 135 | 167 | 173 | | 57 | 129 | 29.9 | 192 | | 7.42 | | 791 | | 672 | 781 |
| 9 | 12600 | | 7.1 | | 7.93 | | 85 | 185 | | 9.80 | 134 | 166 | 172 | | 58 | 128 | 29.8 | 192 | | 7.41 | | 787 | | 668 | 771 |
| 10 | 12150 | | 5.9 | | 7.54 | | 86 | 180 | | 8.62 | 134 | 161 | 174 | | 59 | 135 | 29.7 | 191 | | 6.48 | | 827 | | 710 | 798 |
| 11 | 12150 | | 6.0 | | 7.52 | | 88 | 182 | | 8.58 | 136 | 162 | 174 | | 59 | 139 | 29.5 | 191 | | 6.48 | | 832 | | 715 | 804 |
| 12 | 12100 | | 5.9 | | 7.54 | | 88 | 182 | | 8.55 | 139 | 164 | 174 | | 58 | 142 | 29.3 | 192 | | 6.44 | | 833 | | 716 | 801 |
| 13 | 12100 | | 6.0 | | 7.50 | | 87 | 181 | | 8.51 | 137 | 163 | 174 | | 58 | 139 | 29.3 | 192 | | 6.62 | | 828 | | 711 | 798 |
| 14 | 12200 | | 6.1 | | 7.60 | | 89 | 181 | | 8.65 | 140 | 167 | 174 | | 70 | 144 | 29.2 | 192 | | 6.62 | | 835 | | 717 | 803 |
| 15 | 12200 | | 6.0 | | 7.77 | | 82 | 178 | | 8.77 | 134 | 160 | 174 | | 59 | 135 | 29.1 | 192 | | 6.62 | | 827 | | 710 | 802 |
| 16 | 12200 | | 6.0 | | 7.81 | | 84 | 180 | | 8.78 | 130 | 160 | 174 | | 58 | 136 | 27.0 | 193 | | 6.64 | | 834 | | 716 | 803 |
| 17 | 12200 | | 6.0 | | 7.86 | | 82 | 179 | | 8.81 | 134 | 157 | 175 | | 58 | 137 | 29.3 | 193 | | 6.67 | | 832 | | 714 | 799 |
| 18 | 12200 | | 6.0 | | 7.88 | | 84 | 180 | | 8.80 | 134 | 159 | 175 | | 58 | 136 | 28.9 | 193 | | 6.66 | | 838 | | 719 | 810 |
| 19 | 12200 | | 5.9 | | 7.87 | | 85 | 180 | | 8.30 | 134 | 159 | 175 | | 58 | 136 | 28.9 | 194 | | 6.64 | | 839 | | 721 | 808 |
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SHIFT: 0700-1500 DATE: 4-21-80 TESTER: Slaughter HR. MTR. [illegible] K.W. MTR. [illegible] F.O. MTR.

REMARKS:

SHIFT: 1500-2300 DATE: 4/21/80 TESTER: [illegible]

REMARKS: LINE 17 QB=12579

| CYLINDER TEMP. °F | | | | | | | | ISEA H2O PR. | IN | OUT | 123 | 456 | 789 | 10-11-12 | In H2O | | | | AIR FLOW | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 PSIG | 11 °F | 12 °F | Combined Exhaust | Combined Exhaust | Combined Exhaust | Combined Exhaust | Back Press. | Color | | | INLET T °F | INLET T H2O | Δp H2O | #'S MIN | F/A RATIO | Line No. |
| | | | | | | | | | | | | | | | | | | | | | | | | 1 |
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| 826 | 809 | 873 | 824 | 795 | | | | 25 | 71 | 89 | | | | | 2.9 | CLR | | | 44 | 3.5 | 4.2 | 368.6 | .0248 | 7 |
| 828 | 787 | 876 | 830 | 804 | | | | 25 | 73 | 91 | | | | | 3.1 | CLR | | | 47 | 3.5 | 4.2 | 367.5 | .0257 | 8 |
| 821 | 783 | 870 | 824 | 796 | | | | 27 | 75 | 91 | | | | | 2.8 | CLR | | | 48 | 3.5 | 4.25 | 369.3 | .0248 | 9 |
| 870 | 820 | 913 | 862 | 839 | 850 | ← | | 27 | 75 | 92 | | | | | 2.1 | CLR | | | 48 | 3.0 | 3.5 | 335.3 | .0271 | 10 ← |
| 878 | 836 | 918 | 870 | 847 | 862 | | | 27 | 75 | 91 | | | | | 2.5 | CLR | | | 49 | 3.0 | 3.6 | 359.7 | .0268 | 11 |
| 878 | 830 | 920 | 868 | 846 | 857 | | | 27 | 76 | 92 | | | | | 2.4 | CLR | | | 48 | 2.9 | 3.5 | 335.8 | .0266 | 12 |
| 874 | 824 | 917 | 861 | 840 | 852 | | | 27 | 76 | 92 | | | | | 2.2 | CLR | | | 47 | 3.0 | 3.5 | 335.5 | .0269 | 13 |
| 882 | 857 | 922 | 867 | 847 | 860 | | | 27 | 76 | 92 | | | | | 2.3 | CLR | | | 49 | 2.9 | 3.5 | 335.0 | .0276 | 14 |
| 871 | 828 | 913 | 864 | 838 | 852 | | | 27 | 77 | 94 | | | | | 2.5 | CLR | | | 48 | 2.9 | 3.6 | 340.0 | .0272 | 15 |
| 873 | 836 | 920 | 869 | 846 | 859 | | | 27 | 78 | 95 | | | | | 2.4 | CLR | | | 49 | 3.0 | 3.6 | 339.7 | .0270 | 16 |
| 878 | 835 | 918 | 866 | 850 | 856 | | | 27 | 79 | 96 | | | | | 2.5 | CLR | | | 47 | 3.0 | 3.6 | 340.3 | .0271 | 17 |
| 884 | 841 | 926 | 872 | 862 | 864 | | | 27 | 79 | 95 | | | | | 2.6 | CLR | | | 46 | 3.0 | 3.6 | 340.7 | .0272 | 18 |
| 880 | 844 | 926 | 875 | 864 | 865 | | | 27 | 79 | 96 | | | | | 2.7 | CLR | | | 44 | 2.9 | 3.6 | 344.4 | .0272 | 19 |
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HR. MTR. [illegible] K.W. MTR. 1116 F.O. MTR. [illegible]

SHIFT: 2300 DATE: TESTER: HR. MTR. K.W. MTR. F.O. MTR.

REMARKS:

BF - 4173C

Ignition or Injection Timing 3°ATDC
Comp. Ratio 9.75:1
Gas Cam Timing 25°BTDC @ .020 LIFT
Crankled 19°LL
K. W. Mtr. Constant 12/60
~~[illegible]~~ PEGASUS 495
NATURAL GAS

TEST LOG
EXPERIMENTAL DEPT.

TEST: EMISSIONS SPARK CONTROLLED
ENGINE W 6 [illegible] 10 TURBOSPARK ENGINE NO. 589113

LOG NO. 2771
DATE: 4/25/80

POWER PARTS
C. RING STD. PROD.
LINERS STD PROD.
PISTONS STD. PROD
SPECIAL Elliot H-58
W/0° TWIST TURBINE
BLADES + 21° NOZZLE RING
BAFFLES BETWEEN
Alley

| | | | ENGINE POWER OUTPUT | | | | | | | | MISCELLANEOUS | | | | ENGINE AIR | | | | ENGINE H. O. | | | O/L ENGINE LUB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Press. | | Temp. | | PSIG | Temp. °F | | Press.-PSIG | | | |
| | | | | | | | | | | C.S. / O.C.S. | | | | | In HG | In H.O. | °F | °F | | | | | | | |
| Line No. | Time & Shift | Hour Meter Add | RPM | Sec. for Turns (KW) | KW Meter % Reg. | Alt. KW Output | Alt. Eff. % | BHP | % Load | #1 Pump Rack | Room Temp. | Corrected Barometer | C. C. Vacuum | Gov. Load Limit | Air Receiver | Blower Suction | Air Inlet | Air Receiver | Pump Disch. | To Engine | From Engine | Pump Disch. | To Strainer | To Engine | Upper Header |
| 1 | 0700-1500 HRS 4-25-80 – 0707HRS, START, WARMUP & ON LINE @ 100% 0720HRS | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 0854 | 30.8 | 900 | 42.24 | 98.4 | 1091 | 97.1 | 1506 | 100.4 | | | 29.18 | 2.6 | 5.8 | 10.16 | 7.63 | | 154 | 37 | 167 | 176 | 40.3 | 31.5 | 30.2 | 24.2 |
| 3 | START | | | TEST | | | | | | | | | | | | | | | | | | | | | |
| 4 | 1000 | 31.9 | 900 | 42.41 | 98.4 | 1086 | 97.1 | 1499 | 99.9 | | | 29.19 | 2.9 | 5.75 | 10.18 | 7.64 | | 154 | 37 | 168 | 176 | 40.1 | 31.2 | 30 | 24.1 |
| 5 | 1030 | 32.4 | 900 | 42.45 | | 1086 | | 1499 | 99.9 | | | 29.20 | 2.3 | 5.75 | 10.13 | 7.60 | | 155 | 37 | 168 | 176 | 40.1 | 31 | 29.9 | 24.1 |
| 6 | 1100 | 32.9 | 900 | 42.32 | | 1089 | | 1503 | 100.2 | | | 29.21 | 1.0 | 5.75 | 10.28 | 7.73 | | 154 | 37 | 168 | 176 | 40.1 | 31 | 29.9 | 24 |
| 7 | 1130 | 33.4 | 900 | 42.31 | | 1090 | | 1504 | 100.2 | | | 29.20 | 1.7 | 5.75 | 10.27 | 7.73 | | 154 | 37 | 168 | 177 | 40.1 | 31 | 29.9 | 24 |
| 8 | 1200 | 33.9 | 900 | 42.22 | | 1092 | | 1507 | 100.45 | | | 29.20 | 1.9 | 5.75 | 10.25 | 7.73 | | 154 | 37 | 168 | 177 | 40 | 31 | 29.8 | 23.9 |
| 9 | 1230 | 34.4 | 900 | 42.20 | | 1092 | | 1507 | 100.5 | | | 29.20 | 1.5 | 5.75 | 10.26 | 7.69 | | 154 | 37 | 168 | 176 | 39.9 | 30.9 | 29.7 | 23.8 |
| 10 | 1300 | 34.9 | 900 | 42.20 | | 1092 | | 1507 | 100.5 | | | 29.20 | 1.5 | 5.75 | 10.27 | 7.74 | | 154 | 37 | 169 | 177 | 39.9 | 30.9 | 29.6 | 23.8 |
| 11 | 1330 | 35.4 | 900 | 42.18 | | 1093 | | 1508 | 100.5 | | | 29.20 | 1.0 | 5.75 | 10.22 | 7.70 | | 156 | 37 | 168 | 177 | 39.9 | 30.8 | 29.5 | 23.7 |
| 12 | 1400 | 35.9 | 900 | 42.16 | | 1095 | | 1511 | 100.7 | | | 29.19 | 1.7 | 5.75 | 10.17 | 7.62 | | 157 | 37 | 169 | 177 | 39.8 | 30.4 | 29.1 | 23.5 |
| 13 | 1430 | 36.4 | 900 | 42.19 | | 1093 | | 1508 | 100.5 | | | 29.20 | 1.4 | 5.75 | 10.16 | 7.65 | | 157 | 37 | 169 | 177 | 39.6 | 30.2 | 29.0 | 23.3 |
| 14 | END OF | | | TEST | | | | | | | | | | | | | | | | | | | | | |
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| OIL LUBE -OIL | | | FUEL OIL | | | | | | NATURAL GAS FUEL | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. °F | | | PSIG | | | | | | Press. "HG | | Temp. | | | | | | | | Press.-PSIG | | | | | |
| To Engine | From Engine | Level in C.C. | Fuel Header | Sec. For Lbs. of Fuel | Fuel Cons Lbs./Hr. | Fuel Rate Lbs./BHP-Hr. | Corrected 19350 LB/BHP/HR | Fuel Rate BTU/BHP-Hr. | Meter Inlet PSIG | Meter Inlet ABS Pc | Meter Inlet °F | Meter Inlet ABS °B FTF | Sec. for Ft.³ Gas ΔP | Ft.³/Hr. @ Std. Temp. & Press. QB | Gas Heat Value BTU/Ft.³ | Gas Consumption BTU/Hr. x 10³ | Specific Gas Fuel Rate BTU/BHP-Hr. | Total Specific Fuel Rate BTU/BHP-Hr. | Supply To Engine | Cell Hdr. cs/less | Engine Hdr. | BYPASS PSI | | Line No. |
| | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 162 | 180 | -11 | | | | | | | 71.6 | 85.33 | 73 | .9877 | 27.0 | 12478 | 875 | 10918 | 7250 | | 51.5 | 41.5<br>39 | 35 | 0 | | 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| 162 | 180 | -13 | | | | | | | 70.9 | 85.23 | 73 | .9877 | 27.1 | 12494 | 875 | 10932 | 7293 | | 51.5 | 41.5<br>39 | 35 | 0 | | 4 |
| 163 | 181 | -13 | | | | | | | 70.9 | 85.24 | 74 | .9868 | 27.1 | 12483 | 875 | 10923 | 7287 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 5 |
| 163 | 181 | -15 | | | | | | | 70.7 | 85.04 | 73 | .9877 | 26.9 | 12434 | 875 | 10880 | 72.39 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 6 |
| 163 | 181 | -15 | | | | | | | 70.6 | 84.94 | 73 | .9877 | 26.9 | 12426 | 875 | 10873 | 7229 | | 51.5 | 41.5<br>39 | 35 | 0 | | 7 |
| 163 | 181 | -16 | | | | | | | 70.5 | 84.84 | 73 | 9877 | 26.9 | 12419 | 875 | 10866 | 7211 | | 51.5 | 41.5<br>39 | 35 | 0 | | 8 |
| 163 | 181 | -16 | | | | | | | 70.4 | 84.74 | 74 | .9868 | 27.0 | 12423 | 875 | 10870 | 7213 | | 51.5 | 41.5<br>39 | 35 | 0 | | 9 |
| 164 | 182 | -17 | | | | | | | 70.4 | 84.74 | 74 | .9868 | 26.9 | 12400 | 875 | 10850 | 7200 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 10 |
| 164 | 182 | -19 | | | | | | | 70.4 | 84.74 | 75 | .9859 | 26.9 | 12389 | 875 | 10840 | 7189 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 11 |
| 165 | 183 | -19 | | | | | | | 70.4 | 84.73 | 75 | .9859 | 26.9 | 12389 | 875 | 10840 | 7174 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 12 |
| 165 | 183 | -20 | | | | | | | 70.5 | 84.84 | 74 | .9868 | 26.9 | 12408 | 875 | 10857 | 7199 | | 51.5 | 41.5<br>39 | 35.1 | 0 | | 13 |
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| Line No. | TURBO RPM C.S. | TURBO RPM O.C.S. | COMPRESSOR AIR Pressure To Comp In. H₂O C.S. | O.C.S. | ~~To~~ From Comp. In Hg Psi C.S. | O.C.S. | Temp. °F Inlet | From Comp. C.S. | O.C.S. | Blower Disch Psi | Suct °F | Disch °F | WATER Temps. °F From Turbo. C.S. | O.C.S. | Air Cooler In | Out | LUBE OIL PSIG Turbo. Inlet | Temp. °F From Turbo. C.S. | O.C.S. | TURBINE EXHAUST Press. "HG To C.S. | O.C.S. | Temp. °F To C.S. | O.C.S. | From Turbine | 1 |
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| 2 | 12650 | | 7.5 | | 7.96 | | 84 | 186 | | 10.23 | 110 | 146 | 171 | | 57 | 90 | 31.1 | 189 | | 7.77 | | 769 | | 650 | 767 |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 12675 | | 7.5 | | 8.02 | | 85 | 187 | | 10.25 | 109 | 146 | 172 | | 56 | 90 | 31 | 190 | | 7.78 | | 770 | | 651 | 770 |
| 5 | 12675 | | 7.5 | | 7.92 | | 87 | 188 | | 10.20 | 110 | 146 | 172 | | 57 | 91 | 30.9 | 190 | | 7.74 | | 771 | | 652 | 772 |
| 6 | 12700 | | 7.6 | | 8.06 | | 83 | 185 | | 10.35 | 109 | 145 | 172 | | 57 | 89 | 30.9 | 190 | | 7.84 | | 769 | | 649 | 769 |
| 7 | 12700 | | 7.6 | | 8.06 | | 84 | 186 | | 10.33 | 109 | 145 | 172 | | 57 | 89 | 30.9 | 190 | | 7.83 | | 769 | | 649 | 768 |
| 8 | 12700 | | 7.7 | | 8.09 | | 84 | 187 | | 10.33 | 109 | 145 | 173 | | 57 | 90 | 30.8 | 191 | | 7.83 | | 770 | | 650 | 769 |
| 9 | 12700 | | 7.65 | | 8.06 | | 85 | 187 | | 10.33 | 109 | 145 | 173 | | 57 | 90 | 30.8 | 190 | | 7.83 | | 770 | | 650 | 767 |
| 10 | 12700 | | 7.7 | | 8.08 | | 84 | 186 | | 10.36 | 109 | 146 | 173 | | 57 | 90 | 30.8 | 191 | | 7.85 | | 770 | | 650 | 769 |
| 11 | 12700 | | 7.6 | | 8.06 | | 84 | 186 | | 10.32 | 111 | 146 | 172 | | 56 | 91 | 30.4 | 191 | | 7.83 | | 771 | | 652 | 767 |
| 12 | 12700 | | 7.6 | | 7.96 | | 88 | 191 | | 10.21 | 111 | 148 | 173 | | 55 | 90 | 30.1 | 191 | | 7.73 | | 776 | | 657 | 771 |
| 13 | 12700 | | 7.8 | | 8.00 | | 87 | 189 | | 10.23 | 111 | 148 | 173 | | 55 | 90 | 30 | 192 | | 7.75 | | 775 | | 655 | 770 |
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SHIFT: 0700 - 1500 DATE: 4-25-80 TESTER: Slaughter HR. MTR. [illegible] K.W. MTR. 7117 F.O. MTR. [illegible]

REMARKS:

SHIFT: 1500 DATE: TESTER:

REMARKS:

| CYLINDER TEMP. °F<br>2 | <br>3 | <br>4 | <br>5 | <br>6 | <br>7 | <br>8 | <br>9 | WATER PR<br>10<br>PSI | IN<br>11<br>°F | OUT<br>12<br>°F | 123<br>Combined Exhaust | 456<br>Combined Exhaust | 789<br>Combined Exhaust | 10-11-12<br>Combined Exhaust | in H₂O<br>Back Press. | Color | | | AIR FLOW<br>INLET<br>°F | INLET<br>H₂O" | ΔP<br>H₂O" | #'s<br>MIN | F/A<br>RATIO | FOLD<br>Line No. |
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| 807 | 767 | 853 | 803 | 776 | | | | 27 | 64 | 80 | | | | | 3.0 | CLR | | | 44 | 3.7 | 4.6 | 386.2 | .02397 | 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| 810 | 767 | 853 | 805 | 774 | 797 | | | 27 | 67 | 83 | | | | | 3.1 | CLR | | | 46 | 3.7 | 4.6 | 385.5 | .02410 | 4 ← |
| 811 | 770 | 856 | 808 | 776 | 799 | | | 27 | 69 | 85 | | | | | 3.0 | CLR | | | 47 | 3.7 | 4.55 | 383.1 | .0241 | 5 |
| 808 | 771 | 852 | 804 | 774 | 796 | | | 27 | 69 | 85 | | | | | 3.4 | CLR | | | 47 | 3.7 | 4.6 | 385.3 | .02386 | 6 |
| 809 | 765 | 853 | 804 | 774 | 796 | | | 27 | 71 | 87 | | | | | 3.2 | CLR | | | 47 | 3.7 | 4.6 | 385.2 | .02395 | 7 |
| 808 | 775 | 854 | 805 | 774 | 798 | | | 27 | 72 | 88 | | | | | 3.0 | CLR | | | 47 | 3.7 | 4.6 | 385.2 | .0239 | 8 |
| 809 | 777 | 855 | 807 | 774 | 798 | | | 27 | 73 | 89 | | | | | 3.2 | CLR | | | 48 | 3.7 | 4.6 | 383.6 | .0241 | 9 |
| 810 | 772 | 854 | 804 | 775 | 797 | | | 27 | 73 | 89 | | | | | 3.4 | CLR | | | 49 | 3.8 | 4.6 | 384.4 | .0239 | 10 |
| 813 | 775 | 856 | 807 | 776 | 799 | | | 27 | 74 | 90 | | | | | 3.2 | CLR | | | 51 | 3.8 | 4.6 | 383.7 | .0239 | 11 |
| 818 | 778 | 860 | 811 | 781 | 803 | | | 27 | 75 | 91 | | | | | 3.1 | CLR | | | 51 | 3.8 | 4.6 | 383.6 | .0239 | 12 |
| 816 | 777 | 860 | 812 | 782 | 803 | | | 27 | 76 | 92 | | | | | 3.0 | CLR | | | 50 | 4.0 | 4.6 | 383.9 | .02395 | 13 |
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HR. MTR. K.W. MTR. F.O. MTR.

SHIFT: 2300 DATE: TESTER: HR. MTR. K.W. MTR. F.O. MTR.

REMARKS:

# SECTION 4

# SAMPLING DATA SHEETS

This section includes data sheets for continuous monitoring of gaseous emissions ($O_2$, $CO_2$, NO, $NO_x$, TUHC, and $CH_4$) and particulate mass emissions using EPA's Method 5 and the SASS. The field data sheets are arranged in the following order:

4.1 -- Continuous Monitoring Emission Data

4.2 -- Particulate Mass Emissions - High Volume Stack Sampler (HVSS)

4.3 -- Trace Element and Organic Emissions - Source Assessment Sampling System (SASS)

## 4.1 CONTINUOUS MONITORING EMISSION DATA

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# FIELD DATA SHEET

**ACUREX Aerotherm**

SPARK IGNITION ENGINE - NATURAL GAS

Plant FAIRBANKS MORSE - Colt Industries
Location Beloit, WISCONSIN
Operator Joe Smith of Colt Industries
Date 4-24-80 BASELINE
Load Range 1498 Bhp

Ambient Temperature 46 °F average
Barometric Pressure 29.08 in Hg
~~Static Pressure Duct~~ Humidity = 60 %
Fuel NATURAL GAS

| | | | | DRY UNCORRECTED | | | | | | | CORRECTED TO 15% ~~3%~~ O2 DRY | | | HYDROCARBONS (HC) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | Sample Point | | | $O_2$ % | $CO_2$ % | CO ~~%~~ ppm | $SO_2$ ppm | NO ppm | $NO_x$ ppm | $NO_2$ ppmn | NO ppm | $NO_x$ ppm | $NO_2$ ppm | Total HC | Methane | Non-Methane HC | $H_2O$ % | Stack Gas Temp °F | COMMENTS |
| 12:30 | | | | 13.0 | 4.5 | 190 | - | 710 | 750 | 40 | | | | 790 | 539 | 251 | | | |
| 13:00 | | | | 13.0 | 4.4 | 190 | | 680 | 710 | 30 | | | | 800 | 666 | 134 | | | |
| 13:30 | ENGINE EXHAUST AHEAD OF MUFFLER | | | 12.3 | 4.85 | 180 | | 938 | 987 | 49 | | | | 870 | 711 | 159 | | | |
| 14:00 | | | | 12.3 | 4.9 | 180 | | 925 | 962 | 37 | | | | 860 | 711 | 149 | | | Start of tests |
| 14:30 | | | | 12.1 | 4.95 | 180 | | 950 | 1025 | 75 | | | | 870 | 711 | 159 | | | ↓ ↓ |
| 15:00 | | | | 12.2 | 4.9 | 170 | | 950 | 1025 | 75 | | | | 850 | 688 | 162 | | | |
| 15:30 | | | | 12.2 | 4.9 | 175 | | 935 | 975 | 40 | | | | 950 | 765 | 185 | | | |
| 16:00 | | | | 12.0 | 4.9 | 165 | | 1000 | 1075 | 75 | | | | 840 | 671 | 169 | | | |
| 16:30 | | | | 12.1 | 4.8 | 175 | | 950 | 1000 | 50 | | | | 895 | 726 | 169 | | | |
| 17:00 | | | | 12.0 | 4.9 | 175 | | 1000 | 1075 | 75 | | | | 830 | 704 | 126 | | | |
| 17:30 | | | | 12.1 | 4.9 | 165 | | 975 | 1025 | 50 | | | | 875 | 737 | 138 | | | |
| 18:00 | | | | 12.1 | 4.95 | 150 | | 1037 | 1125 | 88 | | | | 895 | 737 | 158 | | | |
| 18:30 | | | | 12.0 | 4.95 | 165 | | 1037 | 1100 | 63 | | | | 905 | 759 | 146 | | | |
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| | | | | 12.1 | 4.9 | 170 | | 976 | 1040 | 64 | 658 | 701 | 43 | 877 | 721 | 156 | | | AVERAGE |
| | | | | | | | | | | | | | | | | | | | over duration of tests only |

Form EED-063 12/78

ACUREX Aerotherm

# FIELD DATA SHEET

SPARK IGNITION ENGINE - NATURAL GAS

Plant Fairbanks Morse - Colt Industries
Location Beloit, Wisconsin
Operator Joe Smith of Colt Industries
Date 4-25-80 CONTROLLED NOx
Load Range 1505 Bhp

Ambient Temperature 51 °F average (46-56°F)
Barometric Pressure 29.20 in Hg
~~Static Pressure Duct~~ Humidity = 62% (60-64%)
Fuel Natural Gas

| Time | Sample Point | | | DRY UNCORRECTED | | | | | | | CORRECTED TO 15% ~~0%~~ O2 DRY | | | HYDROCARBONS (HC) | | | $H_2O$ % | Stack Gas Temp °F | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $O_2$ % | $CO_2$ % | CO ~~%~~ ppm | $SO_2$ ppm | NO ppm | $NO_x$ ppm | $NO_2$ ppmn | NO ppm | $NO_x$ ppm | $NO_2$ ppm | Total HC | Methane | Non-Methane HC | | | |
| 10:00 | ENGINE EXHAUST AHEAD OF MUFFLER | | | 13.25 | 4.28 | 250 | – | 470 | 495 | 25 | | | | 870 | 719 | 151 | | | Start of tests |
| 10:30 | | | | 13.125 | 4.3 | 255 | | 480 | 500 | 20 | | | | 875 | 719 | 156 | | | ↓ ↓ |
| 11:00 | | | | 13.25 | 4.3 | 260 | | 455 | 490 | 35 | | | | 920 | 750 | 170 | | | |
| 11:30 | | | | 13.25 | 4.28 | 255 | | 465 | 500 | 35 | | | | 900 | 719 | 181 | | | |
| 12:00 | | | | 13.25 | 4.3 | 260 | | 475 | 510 | 35 | | | | 920 | 729 | 191 | | | |
| 12:30 | | | | 13.125 | 4.3 | 260 | | 470 | 500 | 30 | | | | 880 | 714 | 166 | | | |
| 1:00 | | | | 13.2 | 4.3 | 255 | | 475 | 510 | 35 | | | | 900 | 729 | 171 | | | |
| 1:30 | | | | 13.2 | 4.3 | 250 | | 485 | 520 | 35 | | | | 900 | 740 | 160 | | | |
| 2:00 | | | | 13.1 | 4.35 | 240 | | 515 | 530 | 15 | | | | 890 | 729 | 161 | | | |
| 2:30 | | | | 13.2 | 4.35 | 240 | | 510 | 540 | 30 | | | | 890 | 708 | 182 | | | |
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| | | | | 13.2 | 4.4 | 253 | | 480 | 510 | 30 | 369 | 392 | 23 | 895 | 725 | 170 | | | AVERAGE |
| | | | | | | | | | | | | | | | | | | | Over duration of |
| | | | | | | | | | | | | | | | | | | | SASS & Part tests |

Form EED-063 12/78

## 4.2 PARTICULATE MASS EMISSIONS -- HVSS

ACUREX Corporation  PAGE 1 of 2

α = .995  mn : 4.05

# PARTICULATE TEST FIELD DATA SHEET

Plant ˜ COLT - BELOIT, WS

Date 4/24/80

Test Location GAS ENGING

Run Number GAS BASELING

Stack Diameter inches 16.75" avg

Duct Dimensions in. x in. 194.83

Start Time 1533

Operator REIIDER

Barometric Pressure 29.10 @ 0900

Static Pressure + 1.4 " H2O

Stack Pressure 29.20 Hg

Probe Number 5' S.S

Pitot Coefficient .841

Pitot Number 50 SIDE B

Meter Box Number 0016

Orifice Coefficient .694

Nozzle Size & Number .250

Molecular Weight

BWO ASSUMED 5%

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| A29 | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | CO2 | O2 | CO |
|---|---|---|---|---|---|
| 400 | 590 | | | | |
| 400 | 585 | | | | |
| | 20 | THIRD | IMPINGER | | |
| | | | | | |
| | | | | | |
| SILICA GEL | | | | | |
| 600 | 225 | NET | | | |

| SAMPLE POINT | CLOCK TIME | VELOCITY HEAD ΔP in. wg. | ORIFICE METER ΔH in. wg. | GAS METER VOLUME FT³ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | INT LK CK 0.0 ft³/min @ 15 in Hg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INIT | 0 / 1533 | – | – | 969.874 | – | – | – | – | – | – | – | – | | |
| 1 | 5 / 1538 | 2.2 | 4.32 | 974.960 | 608 | 255 | 64 | – | 284 | 57 | 60 | 2.0 | | |
| 2 | 10 / 1543 | 2.2 | 4.32 | 980.370 | 608 | 259 | 69 | – | 267 | 57 | 60 | 1.5 | | |
| 3 | 15 / 1548 | 2.4 | 4.68 | 985.65 | 615 | 273 | 74 | – | 235 | 57 | 60 | 1.5 | | |
| 4 | 20 / 1553 | 2.4 | 4.67 | 991.14 | 618 | 284 | 70 | – | 267 | 57 | 59 | 1.5 | | |
| 5 | 25 / 1558 | 2.2 | 4.29 | 996.65 | 613 | 289 | 66 | – | 266 | 56 | 58 | 1.5 | | |
| 6 | 30 / 1603 | 2.6 | 4.98 | 1002.16 | 638 | 297 | 64 | – | 269 | 58 | 60 | 1.5 | | |
| 7 | 35 / 1608 | 2.5 | 4.79 | 1007.81 | 639 | 303 | 61 | – | 254 | 59 | 61 | 1.5 | | |
| 8 | 40 / 1613 | 2.8 | 5.37 | 1013.50 | 639 | 306 | 60 | – | 255 | 59 | 61 | 2.0 | | |
| 9 | 45 / 1618 | 2.5 | 4.79 | 1019.39 | 637 | 306 | 59 | – | 257 | 59 | 61 | 1.5 | | |
| 10 | 50 / 1623 | 2.6 | 4.97 | 1024.64 | 638 | 308 | 58 | – | 256 | 58 | 60 | 1.5 | | |
| 11 | 55 / 1628 | 2.5 | 4.79 | 1030.30 | 635 | 314 | 57 | – | 258 | 58 | 60 | 1.5 | | |
| 12 | 60 / 1633 | 2.6 | 4.98 | 1035.79 | 635 | 321 | 57 | – | 256 | 57 | 59 | 1.5 | | |
| 13 | 65 / 1638 | 2.6 | 4.99 | 1041.40 | 633 | 328 | 56 | – | 256 | 58 | 59 | 1.5 | | |
| 14 | 70 / 1643 | 2.7 | 5.18 | 1047.02 | 634 | 335 | 57 | – | 243 | 58 | 59 | 2.0 | | |
| 15 | 75 / 1648 | 2.6 | 4.98 | 1052.01 | 634 | 337 | 57 | – | 272 | 57 | 58 | 2.0 | | |
| 16 | 80 / 1653 | 2.7 | 5.16 | 1058.49 | 636 | 338 | 57 | – | 259 | 58 | 58 | 2.0 | | |
| 17 | 85 / 1658 | 2.6 | 4.96 | 1064.28 | 638 | 341 | 57 | – | 240 | 57 | 58 | 2.0 | | |
| STOP 18 | 90 / 1703 | 2.6 | 4.97 | 1069.925 | 639 | 342 | 57 | – | 250 | 58 | 58 | 2.0 | | CHANGE PORTS |
| INIT | 90 / 1710 | | | | | | | | | | | | | |
| AVG/TOTAL | | | | | | | | | | | | | | |

Form EED-021 1 79

**ACUREX Corporation** PAGE 2 OF 2

# PARTICULATE TEST FIELD DATA SHEET

Plant COLT-BELOIT, WS
Date 4/24/80
Test Location GAS ENGINE
Run Number GAS BASELINE
Stack Diameter inches
Duct Dimensions in. x in.
Start Time
Operator

Barometric Pressure
Static Pressure
Stack Pressure
Probe Number
Pitot Coefficient
Pitot Number
Meter Box Number
Orifice Coefficient

Nozzle Size & Number
Molecular Weight
BWO

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | CO2 | O2 | CO |
|---|---|---|---|---|---|
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| SILICA GEL | | | | | |
| | | | | | |

| SAMPLE POINT | CLOCK TIME | VELOCITY HEAD ΔP in. wg. | ORIFICE METER ΔH in. wg. | GAS METER VOLUME FT³ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 95<br>1715 | 1.8 | 3.48 | 1074.61 | 625 | 241 | 58 | — | 248 | 58 | 58 | 2.0 | | |
| 2 | 100<br>1720 | 1.8 | 3.46 | 1079.44 | 627 | 246 | 54 | — | 250 | 56 | 57 | 2.0 | | |
| 3 | 105<br>1725 | 2.0 | 3.87 | 1084.48 | 618 | 251 | 53 | — | 248 | 55 | 56 | 2.0 | | |
| 4 | 110<br>1730 | 2.2 | 4.24 | 1089.70 | 620 | 259 | 53 | — | 250 | 54 | 55 | 2.0 | | |
| 5 | 115<br>1735 | 2.4 | 4.62 | 1095.15 | 622 | 269 | 53 | — | 252 | 54 | 54 | 2.0 | | |
| 6 | 120<br>1740 | 2.4 | 4.63 | 1100.61 | 627 | 282 | 54 | — | 255 | 54 | 54 | 2.0 | | |
| 7 | 125<br>1745 | 2.4 | 4.56 | 1106.05 | 636 | 292 | 55 | — | 257 | 54 | 54 | 2.0 | | |
| 8 | 130<br>1750 | 2.6 | 4.93 | 1111.70 | 636 | 298 | 54 | — | 255 | 54 | 54 | 2.0 | | |
| 9 | 135<br>1755 | 2.4 | 4.52 | 1117.14 | 644 | 307 | 55 | — | 255 | 54 | 54 | 2.0 | | |
| 10 | 140<br>1800 | 2.8 | 5.27 | 1122.91 | 647 | 311 | 56 | — | 254 | 54 | 53 | 2.5 | | |
| 11 | 145<br>1805 | 2.8 | 5.25 | 1128.74 | 649 | 323 | 57 | — | 256 | 55 | 53 | 2.0 | | |
| 12 | 150<br>1810 | 2.9 | 5.43 | 1134.63 | 650 | 335 | 57 | — | 257 | 54 | 53 | 2.0 | | |
| 13 | 155<br>1815 | 2.9 | 5.42 | 1140.50 | 651 | 344 | 57 | — | 256 | 54 | 53 | 2.0 | | |
| 14 | 160<br>1820 | 2.8 | 5.24 | 1146.31 | 652 | 349 | 56 | — | 256 | 54 | 53 | 2.5 | | |
| 15 | 165<br>1825 | 2.7 | 5.03 | 1152.09 | 653 | 352 | 55 | — | 255 | 53 | 52 | 2.0 | | |
| 16 | 170<br>1880 | 2.8 | 5.21 | 1157.74 | 653 | 353 | 55 | — | 250 | 53 | 52 | 2.0 | | |
| 17 | 175<br>1835 | 2.7 | 5.03 | 1163.40 | 653 | 357 | 55 | — | 258 | 53 | 52 | 2.0 | | |
| 18 | 180<br>1840 | 2.7 | 5.03 | 1168.968 | 653 | 358 | 55 | — | 270 | 52 | 52 | 2.0 | | FINAL LEAK CHECK |
| | | | | | | | | | | | | | | 0.000 FT³/MIN |
| | | | | | | | | | | | 55.9 | 56.7 | | |
| AVG/TOTAL | | | 4.789 | | 634.8 | | | | | | 56 | 3 | 1.58 | |

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**ACUREX Corporation** $\alpha$ = .995 K(Nd)$^4$ ÷ 3.87 PAGE 1 OF 2
Ko = .694

# PARTICULATE TEST FIELD DATA SHEET

Plant COLT-BELOIT, WIS
Date 4/25/80
Test Location GAS ENGINE STACK
Run Number CONTROLLED
Stack Diameter inches 15.75 AVG.
Duct Dimensions in. x in.
Start Time 0945
Operator REHDER

Barometric Pressure 29.15" Hg @ 0830
Static Pressure +1.0" $H_2O$
Stack Pressure 29.22" Hg
Probe Number 5'
Pitot Coefficient .841
Pitot Number 50 SIDE "B"
Meter Box Number 0016
Orifice Coefficient .694

Nozzle Size & Number .250"
Molecular Weight
BWO 9% (assumed)

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | $CO_2$ | $O_2$ | CO |
|---|---|---|---|---|---|
| 400 | 570 | | | | |
| 400 | 595 | | | | |
| 0 | 5. | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| SILICA GEL | | | | | |
| 368 | 416 = | 48.0 | gram | $H_2O$ | ($SiO_2$) |

NET

| | SAMPLE POINT | CLOCK TIME | VELOCITY HEAD ΔP in. wg. | ORIFICE METER ΔH in. wg. | GAS METER VOLUME FT³ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-1 | INITIAL | 0/0945 | – | – | 169.615 | – | – | – | – | – | 53 | 53 | – | – | INITIAL |
| | 1 | 5/0950 | 2.2 | 4.36 | 174.30 | 545 | 284 | 58 | – | 209 | 54 | 53 | 1.0 | | LEAK CHECK @ 0842 |
| | 2 | 10/0955 | 2.4 | 4.75 | 179.73 | 545 | 288 | 56 | – | 274 | 54 | 54 | 1.5 | | .008 CFM |
| | 3 | 15/1060 | 2.5 | 4.80 | 185.32 | 575 | 277 | 56 | – | 240 | 56 | 55 | 1.5 | | @ 15" Hg |
| | 4 | 20/1005 | 2.6 | 5.0 | 190.99 | 580 | 277 | 56 | – | 260 | 58 | 56 | 2.0 | | |
| | 5 | 25/1010 | 2.6 | 5.0 | 196.66 | 564 | 284 | 56 | – | 261 | 58 | 57 | 2.0 | | |
| | 6 | 30/1015 | 2.7 | 5.4 | 202.54 | 576 | 287 | 59 | – | 262 | 59 | 58 | 2.0 | | |
| | 7 | 35/1020 | 2.8 | 5.3 | 208.36 | 593 | 294 | 61 | – | 262 | 59 | 58 | 2.0 | | |
| | 8 | 40/1025 | 2.9 | 5.5 | 214.32 | 594 | 298 | 60 | – | 263 | 59 | 58 | 2.0 | | |
| | 9 | 45/1030 | 3.0 | 5.7 | 220.39 | 596 | 303 | 60 | – | 261 | 60 | 59 | 2.0 | | |
| | 10 | 50/1035 | 3.0 | 5.7 | 226.44 | 595 | 308 | 63 | – | 265 | 58 | 58 | 2.0 | | |
| | 11 | 55/1040 | 3.1 | 5.9 | 232.60 | 594 | 314 | 62 | – | 261 | 60 | 58 | 2.0 | | |
| | 12 | 60/1045 | 3.1 | 5.9 | 238.78 | 593 | 321 | 63 | – | 261 | 60 | 58 | 2.0 | | |
| | 13 | 65/1050 | 3.1 | 5.9 | 244.95 | 594 | 328 | 63 | – | 262 | 61 | 59 | 2.0 | | |
| | 14 | 70/1055 | 3.1 | 5.9 | 251.13 | 592 | 331 | 61 | – | 265 | 61 | 59 | 2.0 | | |
| | 15 | 75/1100 | 3.1 | 5.9 | 257.30 | 591 | 332 | 62 | – | 264 | 60 | 59 | 2.0 | | |
| | 16 | 80/1105 | 3.1 | 6.1 | 263.57 | 589 | 333 | 64 | – | 263 | 59 | 59 | 2.0 | | |
| | 17 | 85/1110 | 3.2 | 6.1 | 269.87 | 591 | 334 | 59 | – | 260 | 59 | 59 | 2.0 | | |
| STOP | 18 | 90/1115 | 3.1 | 5.9 | 276.039 | 591 | 335 | 60 | – | 261 | 60 | 58 | 2.5 | | PORT CHANGE |
| START | – | 1210 | – | – | – | – | – | – | – | – | 57 | 57 | – | – | BREAK |
| | AVG/TOTAL | | | | | | | | | | | | | | |

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**ACUREX Corporation**

PAGE 2 OF 2

# PARTICULATE TEST FIELD DATA SHEET

Plant COLT-BELOIT, WS
Date 4/25/80
Test Location GAS ENGINE STACK
Run Number CONTROLLED
Stack Diameter inches
Duct Dimensions in. x in.
Start Time
Operator

Barometric Pressure
Static Pressure
Stack Pressure
Probe Number
Pitot Coefficient
Pitot Number
Meter Box Number
Orifice Coefficient

Nozzle Size & Number
Molecular Weight
BWO

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | CO2 | O2 | CO |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| SILICA GEL | | | | | |
| | | | | | |

S-1

| SAMPLE POINT | CLOCK TIME | VELOCITY HEAD ΔP in. wg. | ORIFICE METER ΔH in. wg. | GAS METER VOLUME FT³ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 95 / 1215 | 2.4 | 4.6 | 281.22 | 578 | 246 | 62 | – | 257 | 56 | 57 | 2.0 | | |
| 2 | 100 / 1220 | 2.4 | 4.6 | 286.57 | 580 | 252 | 69 | – | 255 | 56 | 57 | 2.0 | | |
| 3 | 105 / 1225 | 2.5 | 4.8 | 292.15 | 577 | 256 | 62 | – | 256 | 57 | 57 | 2.0 | | |
| 4 | 110 / 1230 | 2.5 | 4.8 | 297.72 | 580 | 265 | 59 | – | 253 | 59 | 58 | 2.0 | | |
| 5 | 115 / 1235 | 2.6 | 5.0 | 303.40 | 578 | 271 | 60 | – | 256 | 60 | 58 | 2.0 | | |
| 6 | 120 / 1240 | 2.6 | 5.0 | 309.07 | 589 | 281 | 61 | – | 264 | 61 | 59 | 2.0 | | |
| 7 | 125 / 1245 | 2.8 | 5.4 | 314.90 | 589 | 288 | 60 | – | 254 | 62 | 60 | 2.0 | | |
| 8 | 130 / 1250 | 2.8 | 5.4 | 320.83 | 589 | 296 | 63 | – | 255 | 63 | 61 | 2.0 | | |
| 9 | 135 / 1255 | 2.8 | 5.4 | 326.73 | 589 | 300 | 64 | – | 253 | 64 | 62 | 2.0 | | |
| 10 | 140 / 1300 | 3.1 | 6.0 | 332.90 | 592 | 305 | 63 | – | 240 | 66 | 63 | 2.0 | | |
| 11 | 145 / 1305 | 3.4 | 6.5 | 339.38 | 594 | 318 | 64 | – | 281 | 66 | 64 | 2.5 | | |
| 12 | 150 / 1310 | 3.5 | 6.7 MAX | 345.93 | 596 | 333 | 68 | – | 255 | 69 | 65 | 2.5 | | |
| 13 | 155 / 1315 | 3.5 | 6.6 MAX | 352.39 | 599 | 340 | 66 | – | 249 | 70 | 67 | 2.5 | | |
| 14 | 160 / 1320 | 3.5 | 6.5 MAX | 358.89 | 599 | 342 | 65 | – | 249 | 69 | 67 | 2.5 | | |
| 15 | 165 / 1325 | 3.5 | 6.5 MAX | 365.28 | 600 | 344 | 65 | – | 248 | 69 | 68 | 2.5 | | |
| 16 | 170 / 1330 | 3.3 | 6.4 MAX | 371.71 | 602 | 347 | 69 | – | 248 | 70 | 68 | 2.5 | | |
| 17 | 175 / 1335 | 3.3 | 6.4 MAX | 378.17 | 601 | 348 | 63 | – | 254 | 71 | 69 | 2.5 | | |
| 18 | 180 / 1340 | 3.4 | 6.6 MAX | 384.627 | 600 | 349 | 65 | – | 260 | 74 | 71 | 2.5 | | |
| | | | | | | | | | | | | | | FINAL LEAK CHECK @ |
| | | | | | | | | | | 6 | 1 | | | ·007/MIN |
| AVG/TOTAL | | 1.71 | 5.5 | 215.01 | 587 | | | | | 62 | 60 | | | CFM @ 15"Hg |

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## 4.3 TRACE ELEMENT AND ORGANIC EMISSIONS -- SASS

**ACUREX Corporation**

# PARTICULATE TEST FIELD DATA SHEET

Plant CoLT INDUSTRIES
Date 4/24/80
Test Location GAS BASELINE
Run Number SASS #3
Stack Diameter inches 15.75
Duct Dimensions in. x in.
Start Time 1358
Operator P KAUFMANN

Barometric Pressure 29.10
Static Pressure +1.4" $H_2O$
Stack Pressure 29.20
Probe Number
Pitot Coefficient .842
Pitot Number 09
Meter Box Number 088
Orifice Coefficient 3.589/1.166

Nozzle Size & Number .469
Molecular Weight 29.27
BWO

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| A-49 | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | $CO_2$ | $O_2$ | CO |
|---|---|---|---|---|---|
| 500 | 638 | | | | |
| 500 | 537 | | 49 | 12.2 | 82.9 |
| 500 | 453 | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| SILICA GEL | | | | | |
| 847.9 | 1103.6 | | | | |

CARD 1670

| SAMPLE POINT | CLOCK TIME | VELOCITY HEAD $\Delta P$ in. wg. | ORIFICE METER $\Delta H$ in. wg. | GAS METER VOLUME $FT^3$ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | INITIAL LEAK |
| 1358 | 0 | 2.4 | 2.3 | 493.671 | 618 | 419 | 47 | 53 | 411 | 51 | 49 | 19/20 | 1.55 | .018/22" |
| | 45 | 2.4 | 2.2 | 682.35 | 618 | 429 | 46 | 56 | 411 | 66 | 56 | 19/20 | 1.55 | |
| | 90 | 2.4 | 2.1 | 870.3 | 618 | 417 | 46 | 53 | 409 | 61 | 53 | 20/20 | 1.55 | |
| | 135 | 2.4 | 2.1 | 1053.8 | 617 | 436 | 46 | 63 | 409 | 64 | 54 | 20/20 | 1.55 | |
| | 180 | 2.4 | 2.0 | 1238.2 | 629 | 445 | 47 | 56 | 412 | 68 | 56 | 20/20 | 1.55 | |
| OFF | 185 | | | 1257.953 | | | | | | | | | | |
| 1707 | 185 | | | 1257.953 | | | | | | | | | | MOVE TO OTHER PORT |
| | 225 | 2.3 | 2.0 | 1420.6 | 635 | 436 | 46 | 56 | 411 | 65 | 53 | 20/20 | 1.52 | |
| OFF | 250 | | | 1522.780 | | | | | | | | | | |
| | | | | | | | | | | | | | | FINAL LEAK |
| | | | | | | | | | | | | | | .015/20" |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| AVG/TOTAL | 250 | | 2.12 | 1029.109 | 623 | | | | | 58 | | | 1.55 | |

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**ACUREX Corporation**

# PARTICULATE TEST FIELD DATA SHEET

Plant Colt Industries
Date 4/25/80
Test Location Gas Controlled
Run Number Sass 4
Stack Diameter inches 15.75
Duct Dimensions in. x in
Start Time 0952
Operator P Kaufmann

Barometric Pressure 29.15
Static Pressure +1.0" $H_2O$
Stack Pressure 29.22
Probe Number 3 ft Glass
Pitot Coefficient .842
Pitot Number 09
Meter Box Number .088
Orifice Coefficient 3.589/1.166

Nozzle Size & Number .469
Molecular Weight
BWO

FILTER DATA

| NUMBER | TARE | FINAL WT. |
|---|---|---|
| A-60 | | |
| | | |
| | | |

| IMPINGER VOLUMES | | TIME | $CO_2$ | $O_2$ | CO |
|---|---|---|---|---|---|
| 500 | 690 | | | | |
| 500 | 518 | | | | |
| 500 | 447 | | | | |
| | | | | | |
| | | | | | |
| SILICA GEL | | | | | |
| 842 | 1086 | | | | |

Total Moisture 1938.7

Card 1539

| | SAMPLE POINT | CLOCK TIME | VELOCITY HEAD ΔP in. wg | ORIFICE METER ΔH in. wg | GAS METER VOLUME FT³ | TEMPERATURES °F STACK | PROBE | IMPINGER | ORGANIC MODULE | OVEN | GAS METER IN | GAS METER OUT | PUMP VACUUM in. Hg | $\sqrt{\Delta P}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | .025/20" |
| N-1 | 5 | 0 | 2.2 | 2.2 | 524.643 | 576 | 409 | 50 | 53 | 406 | 54 | 51 | 20/20 | | |
| | 5 | 25 | 2.2 | 2.1 | 628.40 | 572 | 410 | 48 | 55 | 414 | 71 | 59 | 20/20 | | |
| | 5 | 50 | 2.5 | 2.1 | 732.30 | 575 | 415 | 47 | 56 | 413 | 72 | 59 | 20/20 | | |
| | 5 | 75 | 2.7 | 2.0 | 834.40 | 574 | 413 | 49 | 54 | 412 | 66 | 57 | 20/20 | | |
| | 5 | 100 | 2.2 | 2.0 | 936.50 | 567 | 412 | 48 | 55 | 412 | 66 | 56 | 20/20 | | |
| | 5 | 131 | 2.2 | 2.0 | 1062.90 | 571 | 413 | 47 | 54 | 402 | 66 | 56 | 20/20 | | Change Ports |
| | Off | 133 | | | 1070.818 | | | | | | | | | | |
| S-1 | 1210 | 133 | 2.4 | 2.0 | | 578 | 412 | 49 | 53 | 414 | 59 | 55 | 20/20 | | |
| | 5 | 150 | 2.5 | 2.0 | 1138.60 | 579 | 410 | 49 | 54 | 414 | 69 | 56 | 20/20 | | |
| | 5 | 175 | 2.5 | 2.0 | 1241.10 | 578 | 411 | 50 | 54 | 413 | 71 | 60 | 20/20 | | |
| | 5 | 206 | 2.4 | 2.0 | 1367.60 | 584 | 414 | 53 | 57 | 417 | 76 | 64 | 20/20 | | |
| | 5 | 225 | 2.4 | 2.0 | 1444.60 | 586 | 412 | 56 | 55 | 415 | 84 | 67 | 20/20 | | |
| | 5 | 253 | 2.4 | 1.9 | 1559.40 | 581 | 413 | 52 | 54 | 414 | 76 | 67 | 20/20 | | Final Leak |
| | Off | 270 | | | 1628.363 | | | | | | | | | | .021/22" |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | 64 | | | | |
| | AVG/TOTAL | | 1.54 | 2.03 | 1103.7 | 576 | | | | | 69 | 59 | | | |

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# SECTION 5
# ANALYTICAL LABORATORY RESULTS

This section contains laboratory reports and calculations of analytical results for fuels and exhaust gas emission samples collected from the spark ignition engine during baseline and controlled $NO_x$ tests. The reports are presented in the following order:

5.1 -- Fuel and lube oil analysis

5.2 -- Particulate mass samples and data reduction

5.3 -- Trace elements

5.4 -- TCO, GRAV, IR, and GC/MS Analyses of Total Sample Extracts

5.5 -- $C_1$ to $C_6$ Hydrocarbon (Gas Chromatography) Data Reduction

5.6 -- Liquid Chromatography of Total Sample Extracts with IR Spectra of LC Fractions

5.7 -- Low Resolution Mass Spectrometry of LC Fractions

5.8 -- Bioassay Analysis Report

## 5.1 FUEL AND LUBE OIL ANALYSES

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## NATURAL GAS COMPOSITION BY GAS CHROMATOGRAPHY (Provided by Fairbanks Morse Division of Colt Industries)

| Components | Mole, % |
|---|---|
| Oxygen | 0.1 |
| Nitrogen | 5.0 |
| Carbon Monoxide | 0 |
| Carbon Dioxide | 0.7 |
| Methane | 89.9 |
| Ethane | 3.4 |
| Propane | 0.8 |
| Iso-Butane | 0.1 |
| n-Pentane | 0.0 |

SPECIFIC GRAVITY RELATIVE TO AIR 0.608

### HEATING VALUE

Btu/ft$^3$ @ 60°F and 30 in. Hg

| | |
|---|---|
| Gross Wet | 979 |
| Gross Dry | 996 |
| Net Wet | 889 |
| Net Dry | 899 |

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LABORATORY CERTIFICATE

**CURTIS & TOMPKINS, LTD.**
ESTABLISHED 1878
ANALYTICAL - **CHEMISTS** - CONSULTING
SAMPLERS — INSPECTORS

MEMBERS OFFICIAL CHEMISTS
AND/OR SAMPLERS FOR MANY
COMMODITY AND TRADE ORGANIZATIONS

CORPORATE OR STAFF MEMBERSHIP IN
PRINCIPAL SCIENTIFIC SOCIETIES

290 DIVISION STREET
SAN FRANCISCO, CALIF. 94103
U.S.A.

CABLE ADDRESS ANALYST

REFEREE ANALYSES
RESEARCH – INVESTIGATIONS
VITAMIN ASSAYS – BIOCHEMISTRY

SPECIALISTS IN BULK COMMODITIES

*Laboratory No.* 80k10
*Preliminary No.* 4132

*Reported* 10/6/80
*Sampled* -------
*Received* 9/8/80

*For* ACUREX CORPORATION

Lube Oil

| | | | |
|---|---|---|---|
| Carbon (C), % -------- | 85.12 | ---- | ---- |
| Hydrogen (H), % ------ | 13.23 | ---- | ---- |
| Oxygen (O), by difference, % ------ | 1.19 | ---- | ---- |
| Nitrogen (N), % ------ | 0.08 | 0.09 | 0.09 |
| Sulfur (S), % -------- | 0.37 | 0.35 | 0.38 |
| Heating Value: BTU/Pound ---------- | 19,157 | ---- | ---- |
| Gravity, °API @ 60°F -------- | 27.40 | ---- | ---- |

*Less than

## 5.2 PARTICULATE MASS SAMPLES AND DATA REDUCTION

Particulate Mass Samples -- Spark Ignited Engine, (grams)

| | SASS Train | | | Method 5 Train | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Solids | | Condensibles | | |
| Test | Probe and nozzle Rinse | Filter | Total | Probe and nozzle rinse | Filter | Impinger inorganics | Impinger organics | Total |
| Baseline | 0.0098 | 0.0417 | 0.0515 | 0.0435 | 0.0758 | 0.0038 | 0.0658 | 0.1799 |
| Controlled $NO_x$ | 0.2210 | 0.0426 | 0.2636 | 0.0201 | 0.1287 | 0.0013 | 0.0673 | 0.2174 |

**ACUREX Corporation**

SASS BASELINE SPARK ENGINE

## PARTICULATE CALCULATIONS

1. Volume of dry gas sampled at standard conditions, 68° F, 29.92 inch Hg (scf)

$$Vm_{std} = 17.64\,\frac{Vm}{\alpha}\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_{m,avg} + 460}\right) = 17.64\,\frac{1029}{1.166}\left(\frac{29.1 + \frac{2.12}{13.6}}{58+460}\right) = 879.316$$

$$\text{or}\quad Vm_{stack} = \left(\frac{Vm}{\alpha} + Vw_{std}\right)\left(\frac{T_{s,avg} + 460}{T_{m,avg} + 460}\right)\left(\frac{P_m}{P_s}\right) \quad \text{(acf at stack conditions)}$$

=

2. Stack gas moisture condensed at standard conditions (scf)

$$Vw_{std} = 0.04707\ Vl_c$$

$$= 0.04707\,(2053.7) = 96.67$$

3. Stack gas proportion of water vapor, by volume

$$B_{wo} = \frac{Vw_{std}}{Vw_{std} + Vm_{std}}$$

$$= 0.099$$

4. Stack gas dry molecular weight (lb/lb-mole)

$$MW_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%N_2 + \%CO)$$

$$= 0.44\,(4.9) + 0.32\,(12.1) + 0.28\,(82.9) = 29.272$$

5. Stack gas molecular weight (lb/lb-mole)

$$MW_s = MW_d\,(1 - B_{wo}) + 18\,(B_{wo})$$

$$= 29.272\,(1 - 0.099) + 18\,(0.099) = 28.156$$

6. Pressure stack, in. Hg

$$P_s = P_b + \frac{P_{st}}{13.6} = 29.10 + \frac{1.4}{13.6}$$

$$= 29.203$$

7. Stack gas velocity at stack conditions (ft/sec)

$$V_s = 85.49\ (C_p)\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_{s,avg} + 460}{P_s\ MW_s}}$$

$$= 85.49(0.841)(1.55)\sqrt{\frac{623+460}{29.203(28.156)}} = 127.896$$

8. Stack gas volume at standard conditions (scfm)

$$Q_s = 60\ (1 - B_{wo})\ Vs_{avg}\ A_s \left(\frac{528}{T_{s,avg} + 460}\right)\left(\frac{P_s}{29.92}\right) = 60(1-0.099)(127.896)(1.353)\left(\frac{528}{1083}\right)\frac{29.2}{29.92}$$

$$= 4451$$

or $Q_a = 60\ Vs_{avg}\ A_s$ (acfm) =

9. Test percent isokinetic

$$\%I = \frac{17.33\ (T_{s,avg} + 460)\ \ [0.04707\ (W_{lc}) + Vm_{std}]}{\theta\ V_s\ P_s\ D_n^2}$$

$$= 89.2\%$$

10. Particulate matter concentration, gr/scf

$$C_s = 15.432\ \frac{M_p}{Vm_{std}} = \frac{15.432}{879.316}\ M_p = 0.0176\ M_p$$

or $C_a = 15.432\ \dfrac{M_p}{Vm_{stack}}$ (gr/acf) =

11. Emission rate of particulate matter, lb/hr

$$ER = 0.00857\ (Q_s)\ C_s$$

$$= 0.00857(4451)(0.0176)\ M_p = 0.6694\ M_p$$

12. Percent excess air at sampling point

$$\%\ EA = \frac{100\ [\%O_2 - 0.5\ (\%CO)]}{0.264\ \ \%N_2 - (\%O_2 - 0.5 \times \%CO)} =$$

$M_p$ (probe + filter) = 0.0515 grams

ER = 0.0345 lb/hr

= 0.0104 g/Bhp-hr

13. Emission rate of particulate matter, lb/$10^6$ Btu

$$E = 2.679 \times 10^{-6} \left(\frac{M_p}{Vm_{std}}\right) F \left(\frac{20.9}{20.9 - \%O_2}\right)$$

=

**ACUREX Corporation**

METHOD 5 BASELINE SPARK ENGINE

## PARTICULATE CALCULATIONS

1. Volume of dry gas sampled at standard conditions, 68° F, 29.92 inch Hg (scf)

$$Vm_{std} = 17.64 \frac{Vm}{\alpha} \left( \frac{P_b + \frac{\Delta H}{13.6}}{T_{m,avg} + 460} \right) = 17.64 \left( \frac{199.094}{0.995} \right) \left( \frac{29.1 + \frac{4.789}{13.6}}{56.3 + 460} \right) = 201.35$$

$$\text{or } Vm_{stack} = \left( \frac{Vm}{\alpha} + Vw_{std} \right) \left( \frac{T_{s,avg} + 460}{T_{m,avg} + 460} \right) \left( \frac{P_m}{P_s} \right) \text{ (acf at stack conditions)}$$

$$= 201.35$$

2. Stack gas moisture condensed at standard conditions (scf)

$$Vw_{std} = 0.04707\ Vl_c$$

$$= 0.04707(417) = 19.63$$

3. Stack gas proportion of water vapor, by volume

$$B_{wo} = \frac{Vw_{std}}{Vw_{std} + Vm_{std}}$$

$$= \frac{19.63}{19.63 + 201.35} = 0.089$$

4. Stack gas dry molecular weight (lb/lb-mole)

$$MW_d = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO)$$

$$= 0.44(4.9) + 0.32(12.1) + 0.28(82.9) = 29.27$$

5. Stack gas molecular weight (lb/lb-mole)

$$MW_s = MW_d\ (1 - B_{wo}) + 18\ (B_{wo})$$

$$= 29.27(1 - 0.089) + 18(0.089) = 28.27$$

6. Pressure stack, in. Hg

$$P_s = P_b + \frac{P_{st}}{13.6}$$

$$= 29.10 + \frac{1.4}{13.6} = 29.20$$

7. Stack gas velocity at stack conditions (ft/sec)

$$V_s = 85.49\ (C_p)\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_{s,avg} + 460}{P_s\ MW_s}}$$

$$= 85.49(0.841)(1.58)\sqrt{\frac{635 + 460}{29.2(28.27)}} = 130.77$$

8. Stack gas volume at standard conditions (scfm)

$$Q_s = 60\ (1 - B_{wo})\ Vs_{avg}\ A_s \left(\frac{528}{T_{s,avg} + 460}\right)\left(\frac{P_s}{29.92}\right) = 60(1-0.089)(130.8)(1.353)\left(\frac{528}{1045}\right)\left(\frac{29.2}{29.92}\right)$$

or $Q_a = 60\ Vs_{avg}\ A_s$ (acfm) = 4558

9. Test percent isokinetic

$$\%I = \frac{17.33\ (T_{s,avg} + 460)\ \ [0.04707\ (W_{lc}) + Vm_{std}]}{\theta\ V_s\ P_s\ D_n^2}$$

$$= 97.6\ \%$$

10. Particulate matter concentration, gr/scf

$$C_s = 15.432 \frac{M_p}{Vm_{std}} = \frac{15.432}{201.35} M_p = 0.0766\ M_p$$

or $C_a = 15.432 \dfrac{M_p}{Vm_{stack}}$ (gr/acf) =

11. Emission rate of particulate matter, lb/hr

$$ER = 0.00857\ (Q_s)\ C_s$$

$$= 0.00857(4558)(0.0766)\ M_p = 2.9938\ M_p$$

12. Percent excess air at sampling point

$$\%\ EA = \frac{100\ [\%O_2 - 0.5\ (\%CO)]}{0.264\ \ \%N_2 - (\%O_2 - 0.5 \times \%CO)} =$$

13. Emission rate of particulate matter, lb/$10^6$ Btu

$$E = 2.679 \times 10^6 \left(\frac{M_p}{Vm_{std}}\right) F \left(\frac{20.9}{20.9 - \%O_2}\right)$$

=

| | Probe + filter | Condensible | Total |
|---|---|---|---|
| $M_p$ | 0.1193 | 0.0606 | 0.1799 |
| ER lb/hr | 0.3572 | 0.1814 | 0.5386 |
| ER lb/Btu-hr | 0.1082 | 0.0550 | 0.1632 |
| | | | |

**ACUREX Corporation**

SASS CONTROLLED NOx SPARK ENGINE

## PARTICULATE CALCULATIONS

1. Volume of dry gas sampled at standard conditions, 68° F, 29.92 inch Hg (scf)

$$Vm_{std} = 17.64\ \frac{Vm}{\alpha}\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_{m,avg} + 460}\right) =$$

$$\text{or}\quad Vm_{stack} = \left(\frac{Vm}{\alpha} + Vw_{std}\right)\left(\frac{T_{s,avg} + 460}{T_{m,avg} + 460}\right)\left(\frac{P_m}{P_s}\right)\quad \text{(acf at stack conditions)}$$

$$= 17.64\ \frac{1103.7}{1.166}\left(\frac{29.15 + \frac{2.03}{13.6}}{64 + 460}\right) = 933.6$$

2. Stack gas moisture condensed at standard conditions (scf)

$$Vw_{std} = 0.04707\ Vl_c$$

$$= 0.04707(1938.7) = 91.25$$

3. Stack gas proportion of water vapor, by volume

$$B_{wo} = \frac{Vw_{std}}{Vw_{std} + Vm_{std}}$$

$$= \frac{91.25}{91.25 + 933.6} = 0.09$$

4. Stack gas dry molecular weight (lb/lb-mole)

$$MW_d = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO)$$

$$= 0.44(4.4) + 0.32(12.1) + 0.28(83.5) = 29.19$$

5. Stack gas molecular weight (lb/lb-mole)

$$MW_s = MW_d\ (1 - B_{wo}) + 18\ (B_{wo})$$

$$= 29.19(1 - 0.09) + 18(0.09) = 28.18$$

6. Pressure stack, in. Hg

$$P_s = P_b + \frac{P_{st}}{13.6}$$

$$= 29.15 + \frac{1.0}{13.6} = 29.22$$

7. Stack gas velocity at stack conditions (ft/sec)

$$V_s = 85.49\ (C_p)\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_{s,avg} + 460}{P_s\ MW_s}}$$

$$= 85.49(0.842)(1.54)\sqrt{\frac{576 + 460}{29.22(28.18)}} \quad = 124.34$$

8. Stack gas volume at standard conditions (scfm)

$$Q_s = 60\ (1 - B_{wo})\ Vs_{avg}\ A_s \left(\frac{528}{T_{s,avg} + 460}\right)\left(\frac{P_s}{29.92}\right) =$$

or $Q_a = 60\ Vs_{avg}\ A_s$ (acfm) = $60(1-0.09)(124.34)(1.353)\left(\frac{528}{1036}\right)\left(\frac{29.22}{29.92}\right) = 4571.9$

9. Test percent isokinetic

$$\%I = \frac{17.33\ (T_{s,avg} + 460)\ \ [0.04707\ (W_{lc}) + Vm_{std}]}{\theta\ V_s\ P_s\ D_n^2}$$

$$= \frac{17.33(1036)[0.04707(1938.7) + 933.6]}{270(124.34)(29.22)(0.469)^2} \quad = 85.3\ \%$$

10. Particulate matter concentration, gr/scf

$$C_s = 15.432 \frac{M_p}{Vm_{std}} = \quad \frac{15.432}{933.6} M_p \quad = 0.0165\ (M_p)$$

or $C_a = 15.432 \dfrac{M_p}{Vm_{stack}}$ (gr/acf) =

11. Emission rate of particulate matter, lb/hr

$$ER = 0.00857\ (Q_s)\ C_s$$

$$= 0.00857(4571.9)(0.0165)\ M_p = 0.6476\ M_p$$

12. Percent excess air at sampling point

$$\%\ EA = \frac{100\ [\%O_2 - 0.5\ (\%CO)]}{0.264\ \ \%N_2 - (\%O_2 - 0.5 \times \%CO)} =$$

13. Emission rate of particulate matter, lb/$10^6$ Btu

$$E = 2.679 \times 10^{-6} \left(\frac{M_p}{Vm_{std}}\right) F \left(\frac{20.9}{20.9 - \%O_2}\right)$$

=

| | Probe + filter |
|---|---|
| Mp | 0.2210+0.0426= 0.2636 |
| ER lb/hr | 0.1707 |
| FIL g/Bhp-hr | 0.0515 |

**ACUREX Corporation**

METHOD 5 CONTROLLED NOx SPARK ENGINE

## PARTICULATE CALCULATIONS

1. Volume of dry gas sampled at standard conditions, 68° F, 29.92 inch Hg (scf)

$$Vm_{std} = 17.64 \frac{Vm}{\alpha} \left( \frac{P_b + \frac{\Delta H}{13.6}}{T_{m,avg} + 460} \right) = 17.64 \frac{215.01}{0.995} \left( \frac{29.22 + \frac{5.5}{13.6}}{61 + 460} \right) = 216.74$$

$$\text{or} \quad Vm_{stack} = \left( \frac{Vm}{\alpha} + Vw_{std} \right) \left( \frac{T_{s,avg} + 460}{T_{m,avg} + 460} \right) \left( \frac{P_m}{P_s} \right) \quad \text{(acf at stack conditions)}$$

=

2. Stack gas moisture condensed at standard conditions (scf)

$$Vw_{std} = 0.04707 \, Vl_c$$

$$= 0.04707 \, (413) = 19.44$$

3. Stack gas proportion of water vapor, by volume

$$B_{wo} = \frac{Vw_{std}}{Vw_{std} + Vm_{std}}$$

$$= \frac{19.44}{19.44 + 216.74} = 0.08$$

4. Stack gas dry molecular weight (lb/lb-mole)

$$MW_d = 0.44 \, (\%CO_2) + 0.32 \, (\%O_2) + 0.28 \, (\%N_2 + \%CO)$$

$$= 0.44 (4.4) + 0,32 (13,2) + 0,28 (82.42) = 29,24$$

5. Stack gas molecular weight (lb/lb-mole)

$$MW_s = MW_d \, (1 - B_{wo}) + 18 \, (B_{wo})$$

$$= 29.24 (1 - 0.08) + 18 (0.08) = 28.34$$

6. Pressure stack, in. Hg

$$P_s = P_b + \frac{P_{st}}{13.6}$$

$$= 29.22 + \frac{1.0}{13.6} = 29.29$$

7. Stack gas velocity at stack conditions (ft/sec)

$$V_s = 85.49\ (C_p)\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_{s,avg} + 460}{P_s\ MW_s}}$$

$$= 85.49(0.841)(1.71)\sqrt{\frac{1047}{29.29(28.34)}} = 138.1$$

8. Stack gas volume at standard conditions (scfm)

$$Q_s = 60\ (1 - B_{wo})\ Vs_{avg}\ A_s \left(\frac{528}{T_{s,avg} + 460}\right)\left(\frac{P_s}{29.92}\right) =$$

or $Q_a = 60\ Vs_{avg}\ A_s$ (acfm) = $60(0.92)(138.1)(1.353)\left(\frac{528}{1047}\right)\frac{29.29}{29.92} = 5091.85$

9. Test percent isokinetic

$$\%I = \frac{17.33\ (T_{s,avg} + 460)\ \ [0.04707\ (W_{lc}) + Vm_{std}]}{\theta\ V_s\ P_s\ D_n^2}$$

$$= \frac{17.33(1047)[19.44 + 216.74]}{120(138.1)(29.29)(.25)^2} = 94.17\ \%$$

10. Particulate matter concentration, gr/scf

$$C_s = 15.432 \frac{M_p}{Vm_{std}} = \frac{15.432}{216.74} M_p = 0.071\ M_p$$

or $C_a = 15.432 \dfrac{M_p}{Vm_{stack}}$ (gr/acf) =

11. Emission rate of particulate matter, lb/hr

$$ER = 0.00857\ (Q_s)\ C_s$$

$$= 0.00857(5091.85)0.071\ M_p = 3.098\ M_p$$

12. Percent excess air at sampling point

$$\%\ EA = \frac{100\ [\%O_2 - 0.5\ (\%CO)]}{0.264\ \ \%N_2 - (\%O_2 - 0.5 \times \%CO)} =$$

13. Emission rate of particulate matter, lb/$10^6$ Btu

$$E = 2.679 \times 10^6 \left(\frac{M_p}{Vm_{std}}\right) F \left(\frac{20.9}{20.9 - \%O_2}\right)$$

=

| | filter + probe | condensibles | total |
|---|---|---|---|
| $M_p$ = | 0.1488 | 0.0686 | 0.2174 |
| ER lb/hr | 0.4609 | 0.2125 | 0.6734 |
| ER g/bhp-hr | 0.1391 | 0.0641 | 0.2032 |

## 5.3 TRACE ELEMENTS

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

SINCE 1908

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 23, 1980

Analyst: T. Bouts

P. O. No.:

Sample No.: 80-1535

XAD - BLANK

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.3 |
| Thorium | | Gadolinium | | Molybdenum | 0.4 | Titanium | 2 |
| Bismuth | <0.1 | Europium | | Niobium | | Scandium | <0.1 |
| Lead | 0.6 | Samarium | | Zirconium | 1 | Calcium | 170 |
| Thallium | | Neodymium | | Yttrium | <0.1 | Potassium | 24 |
| Mercury | NR | Praseodymium | 0.2 | Strontium | 0.2 | Chlorine | 1 |
| Gold | | Cerium | 0.9 | Rubidium | <0.1 | Sulfur | 9 |
| Platinum | | Lanthanum | 2 | Bromine | 0.4 | Phosphorus | 26 |
| Iridium | | Barium | 1 | Selenium | 0.2 | Silicon | *MC |
| Osmium | | Cesium | | Arsenic | <0.1 | Aluminum | 13 |
| Rhenium | | Iodine | <0.1 | Germanium | 0.2 | Magnesium | 17 |
| Tungsten | | Tellurium | | Gallium | 0.1 | Sodium | 98 |
| Tantalum | ≤0.6 | Antimony | 0.2 | Zinc | 6 | Fluorine | ≈3 |
| Hafnium | | Tin | 0.1 | Copper | 13 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | MC | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | 3 | Carbon | NR |
| Thulium | | Silver | | Iron | 120 | Boron | <0.1 |
| Erbium | | Palladium | | Manganese | 39 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 29 | Lithium | 0.1 |
| Dysprosium | | | | | | Hydrogen | NR |

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved:
5-19

**COMMERCIAL TESTING & ENGINEERING CO.**
Reply to
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 22, 1980

Analyst: L. Jacobs

P. O. No.:

Sample No.: 80-1544

First Impinger Blank

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN µg/ml

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.001 |
| Thorium | | Gadolinium | | Molybdenum | 0.01 | Titanium | 0.09 |
| Bismuth | | Europium | | Niobium | | Scandium | |
| Lead | 0.07 | Samarium | | Zirconium | | Calcium | 2 |
| Thallium | | Neodymium | | Yttrium | | Potassium | 0.5 |
| Mercury | NR | Praseodymium | | Strontium | | Chlorine | 0.1 |
| Gold | | Cerium | | Rubidium | <0.001 | Sulfur | 0.2 |
| Platinum | | Lanthanum | | Bromine | 0.003 | Phosphorus | 0.9 |
| Iridium | | Barium | 0.04 | Selenium | | Silicon | 2 |
| Osmium | | Cesium | | Arsenic | | Aluminum | MC |
| Rhenium | | Iodine | | Germanium | | Magnesium | *0.9 |
| Tungsten | | Tellurium | | Gallium | | Sodium | 0.5 |
| Tantalium | | Antimony | | Zinc | 0.03 | Fluorine | |
| Hafnium | | Tin | | Copper | <0.001 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.03 | Nitrogen | NR |
| Ytterbium | | Cadmium | ≤0.01 | Cobalt | 0.007 | Carbon | NR |
| Thulium | | Silver | | Iron | 1 | Boron | <0.001 |
| Erbium | | Palladium | | Manganese | 0.02 | Beryllium | <0.001 |
| Holmium | | Rhodium | | Chromium | 0.001 | Lithium | <0.001 |
| Dysprosium | | | | | | Hydrogen | NR |

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.002 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: M Jacobs
5-20

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 25, 1980

Analyst: T. Bouts

P. O. No.:

Sample No.: A-45 Blank

FILTER BLANK

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

CONCENTRATION IN μg/cm$^2$

IAD No.: 97-E697-116-28

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | ≤0.008 | Terbium | | Ruthenium | | Vanadium | 0.02 |
| Thorium | 0.01 | Gadolinium | | Molybdenum | 0.005 | Titanium | 0.9 |
| Bismuth | | Europium | | Niobium | 0.01 | Scandium | 0.002 |
| Lead | 0.007 | Samarium | | Zirconium | 0.05 | Calcium | MC |
| Thallium | | Neodymium | 0.004 | Yttrium | 0.003 | Potassium | 0.5 |
| Mercury | NR | Praseodymium | 0.003 | Strontium | 0.04 | Chlorine | 0.4 |
| Gold | <0.001 | Cerium | 0.01 | Rubidium | <0.001 | Sulfur | 0.8 |
| Platinum | | Lanthanum | 0.02 | Bromine | 0.03 | Phosphorus | 0.07 |
| Iridium | | Barium | 0.2 | Selenium | 0.005 | Silicon | MC |
| Osmium | | Cesium | | Arsenic | 0.001 | Aluminum | MC |
| Rhenium | | Iodine | 0.001 | Germanium | | Magnesium | 1 |
| Tungsten | 0.01 | Tellurium | | Gallium | 0.008 | Sodium | >2 |
| Tantalum | | Antimony | | Zinc | 0.01 | Fluorine | ≈0.005 |
| Hafnium | | Tin | | Copper | 0.01 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.01 | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | <0.001 | Carbon | NR |
| Thulium | | Silver | 0.001 | Iron | 0.2 | Boron | 0.9 |
| Erbium | | Palladium | | Manganese | 0.003 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 0.02 | Lithium | <0.001 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 μg/cm$^2$
MC — Major Component > 10 μg/cm$^2$
INT — Interference

Approved:

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 25, 1980

Analyst: C. Wilson

P. O. No.:

Sample No.: 80-1522

SPARK ENGINE - BASELINE FILTER

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN $\mu g/cm^2$

IAD No.: 97-E697-116-28

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | <0.001 | Terbium | | Ruthenium | | Vanadium | 0.001 |
| Thorium | <0.001 | Gadolinium | | Molybdenum | 0.1 | Titanium | 0.1 |
| Bismuth | | Europium | | Niobium | <0.01 | Scandium | <0.001 |
| Lead | 0.002 | Samarium | | Zirconium | 0.01 | Calcium | 10 |
| Thallium | | Neodymium | <0.001 | Yttrium | <0.001 | Potassium | 0.03 |
| Mercury | NR | Praseodymium | <0.001 | Strontium | 0.02 | Chlorine | 0.02 |
| Gold | | Cerium | 0.001 | Rubidium | <0.001 | Sulfur | MC |
| Platinum | | Lanthanum | 0.01 | Bromine | 0.002 | Phosphorus | 0.3 |
| Iridium | | Barium | 0.03 | Selenium | <0.001 | Silicon | MC |
| Osmium | | Cesium | | Arsenic | <0.001 | Aluminum | MC |
| Rhenium | | Iodine | <0.001 | Germanium | 0.002 | Magnesium | 0.8 |
| Tungsten | *<0.001 | Tellurium | | Gallium | <0.001 | Sodium | 0.05 |
| Tantalum | | Antimony | | Zinc | 0.2 | Fluorine | ≈0.06 |
| Hafnium | | Tin | 0.002 | Copper | 0.007 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.003 | Nitrogen | NR |
| Ytterbium | | Cadmium | <0.001 | Cobalt | <0.001 | Carbon | NR |
| Thulium | | Silver | <0.001 | Iron | 0.04 | Boron | 0.1 |
| Erbium | | Palladium | | Manganese | <0.001 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 0.01 | Lithium | 0.002 |
| Dysprosium | | | | | | Hydrogen | NR |

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 $\mu g/cm^2$
MC — Major Component > 10 $\mu g/cm^2$
INT — Interference

Approved: M Jacobs

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 25, 1980

Analyst: C. Wilson

P. O. No.:

Sample No.: 80-1523

SPARK ENGINE
LOW NOx FILTER

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN $\mu g/cm^2$

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | 0.001 | Terbium | | Ruthenium | | Vanadium | 0.008 |
| Thorium | 0.003 | Gadolinium | | Molybdenum | 0.007 | Titanium | 0.4 |
| Bismuth | | Europium | | Niobium | 0.002 | Scandium | 0.002 |
| Lead | 0.02 | Samarium | <0.001 | Zirconium | 0.04 | Calcium | MC |
| Thallium | | Neodymium | 0.004 | Yttrium | 0.001 | Potassium | 0.3 |
| Mercury | NR | Praseodymium | 0.002 | Strontium | 0.05 | Chlorine | 0.06 |
| Gold | | Cerium | 0.006 | Rubidium | <0.001 | Sulfur | MC |
| Platinum | | Lanthanum | 0.006 | Bromine | 0.006 | Phosphorus | 6 |
| Iridium | | Barium | 0.2 | Selenium | 0.001 | Silicon | MC |
| Osmium | | Cesium | <0.001 | Arsenic | 0.001 | Aluminum | MC |
| Rhenium | | Iodine | | Germanium | <0.001 | Magnesium | 3 |
| Tungsten | 0.001 | Tellurium | | Gallium | 0.002 | Sodium | >0.4 |
| Tantalum | | Antimony | <0.001 | Zinc | 0.7 | Fluorine | ≈0.4 |
| Hafnium | | Tin | 0.005 | Copper | 0.04 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.05 | Nitrogen | NR |
| Ytterbium | | Cadmium | <0.001 | Cobalt | <0.001 | Carbon | NR |
| Thulium | | Silver | 0.01 | Iron | 0.4 | Boron | 1 |
| Erbium | | Palladium | | Manganese | 0.008 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 0.08 | Lithium | 0.02 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected $<0.001\ \mu g/cm^2$
MC — Major Component $> 10\ \mu g/cm^2$
INT — Interference

Approved: M Jacobs

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 22, 1980

Analyst: C. Wilson

P. O. No.:

Sample No.: 80-1561
SPARK ENGINE
LUBE OIL

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.06 |
| Thorium | | Gadolinium | | Molybdenum | 0.8 | Titanium | 9 |
| Bismuth | | Europium | | Niobium | | Scandium | ≤0.04 |
| Lead | 1 | Samarium | | Zirconium | | Calcium | MC |
| Thallium | | Neodymium | | Yttrium | | Potassium | 46 |
| Mercury | | Praseodymium | | Strontium | 2 | Chlorine | 13 |
| Gold | | Cerium | | Rubidium | 0.07 | Sulfur | MC |
| Platinum | | Lanthanum | | Bromine | 0.3 | Phosphorus | MC |
| Iridium | | Barium | 1 | Selenium | | Silicon | 43 |
| Osmium | | Cesium | | Arsenic | ≤0.2 | Aluminum | >37 |
| Rhenium | | Iodine | 0.2 | Germanium | | Magnesium | MC |
| Tungsten | | Tellurium | | Gallium | | Sodium | >96 |
| Tantalium | | Antimony | | Zinc | MC | Fluorine | ≈3 |
| Hafnium | | Tin | 0.9 | Copper | 3 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 1 | Nitrogen | NR |
| Ytterbium | | Cadmium | ≤0.07 | Cobalt | 0.6 | Carbon | NR |
| Thulium | | Silver | | Iron | 30 | Boron | 0.4 |
| Erbium | | Palladium | | Manganese | 0.6 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 9 | Lithium | 0.2 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected <0.03 ppm
MC — Major Component > 100 ppm
INT — Interference

5-24

Approved: M J Jacobs

# COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 24, 1980

Analyst: T. Bouts

P. O. No.:

Sample No.: 80-1536

SPARK BASELINE
XAD

IAD No.: 97-E697-116-28

## SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
## CONCENTRATION IN PPM WEIGHT

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.2 |
| Thorium | | Gadolinium | | Molybdenum | 6 | Titanium | 0.8 |
| Bismuth | | Europium | | Niobium | | Scandium | <0.1 |
| Lead | 0.4 | Samarium | | Zirconium | 0.2 | Calcium | 93 |
| Thallium | | Neodymium | | Yttrium | | Potassium | 18 |
| Mercury | NR | Praseodymium | <0.1 | Strontium | 1 | Chlorine | 0.7 |
| Gold | | Cerium | 0.8 | Rubidium | <0.1 | Sulfur | 20 |
| Platinum | | Lanthanum | 2 | Bromine | 0.5 | Phosphorus | 28 |
| Iridium | | Barium | 2 | Selenium | | Silicon | 78 |
| Osmium | | Cesium | | Arsenic | <0.1 | Aluminum | 7 |
| Rhenium | | Iodine | <0.1 | Germanium | | Magnesium | 19 |
| Tungsten | | Tellurium | | Gallium | <0.1 | Sodium | 8 |
| Tantalum | | Antimony | | Zinc | 2 | Fluorine | ≈2 |
| Hafnium | | Tin | | Copper | 9 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 270 | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | 1 | Carbon | NR |
| Thulium | | Silver | | Iron | 110 | Boron | <0.1 |
| Erbium | | Palladium | | Manganese | 1 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 30 | Lithium | <0.1 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

5-25
Approved: M Jacobs

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 24, 1980

Analyst: T. Bouts

P. O. No.:

Sample No.: 80-1537
SPARK CONTROLLED
XAD

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.5 |
| Thorium | | Gadolinium | | Molybdenum | 1 | Titanium | 6 |
| Bismuth | | Europium | | Niobium | | Scandium | <0.1 |
| Lead | 0.6 | Samarium | | Zirconium | 0.4 | Calcium | 230 |
| Thallium | | Neodymium | 0.1 | Yttrium | <0.1 | Potassium | 45 |
| Mercury | NR | Praseodymium | 0.2 | Strontium | 0.3 | Chlorine | 0.9 |
| Gold | | Cerium | 1 | Rubidium | <0.1 | Sulfur | 16 |
| Platinum | | Lanthanum | 2 | Bromine | 0.3 | Phosphorus | 38 |
| Iridium | | Barium | 2 | Selenium | | Silicon | 56 |
| Osmium | | Cesium | | Arsenic | <0.1 | Aluminum | 17 |
| Rhenium | | Iodine | | Germanium | <0.1 | Magnesium | 18 |
| Tungsten | | Tellurium | | Gallium | 0.3 | Sodium | 43 |
| Tantalum | ≤0.8 | Antimony | | Zinc | 11 | Fluorine | ≈2 |
| Hafnium | | Tin | ≤0.4 | Copper | 54 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | MC 2.5 | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | 9 | Carbon | NR |
| Thulium | | Silver | | Iron | 480 | Boron | 0.9 |
| Erbium | | Palladium | | Manganese | 51 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 46 | Lithium | <0.1 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

5-26
Approved: M Jacobs

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 22, 1980

Analyst: L. Jacobs

P. O. No.:

Sample No.: 80-1547

SPARK BASELINE
1st IMPINGER & OMC

IAD No.: 97-E697-116-28

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN μg/ml

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.004 |
| Thorium | | Gadolinium | | Molybdenum | 0.02 | Titanium | 0.06 |
| Bismuth | | Europium | | Niobium | 0.008 | Scandium | <0.001 |
| Lead | 0.3 | Samarium | | Zirconium | ≤0.001 | Calcium | 9 |
| Thallium | | Neodymium | | Yttrium | <0.001 | Potassium | MC |
| Mercury | NR | Praseodymium | | Strontium | 0.004 | Chlorine | 0.2 |
| Gold | | Cerium | 0.002 | Rubidium | 0.007 | Sulfur | MC |
| Platinum | | Lanthanum | | Bromine | 0.02 | Phosphorus | 0.9 |
| Iridium | | Barium | 0.06 | Selenium | 0.7 | Silicon | 6 |
| Osmium | | Cesium | 0.002 | Arsenic | <0.001 | Aluminum | MC |
| Rhenium | | Iodine | 0.003 | Germanium | 0.001 | Magnesium | 0.2 |
| Tungsten | | Tellurium | 0.02 | Gallium | 0.009 | Sodium | MC |
| Tantalium | | Antimony | 0.001 | Zinc | 2 | Fluorine | ≈0.2 |
| Hafnium | | Tin | 0.01 | Copper | 3 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.3 | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | 0.002 | Carbon | NR |
| Thulium | | Silver | 0.02 | Iron | 0.6 | Boron | |
| Erbium | | Palladium | | Manganese | 0.03 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 0.2 | Lithium | <0.001 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 μg/ml
MC — Major Component > 10 μg/ml
INT — Interference

5-27

Approved: Jacobs

**COMMERCIAL TESTING & ENGINEERING CO.**
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Brent Higginbotham
Acurex Corporation
485 Clyde Ave.
Mountain View, CA 94042

Date: September 22, 1980

Analyst: L. Jacobs

P. O. No.:

Sample No.: 80-1548

IAD No.: 97-E697-116-28

SPARK CONTROLLED
1st IMPINGER & OMC

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN µg/ml

| ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. | ELEMENT | CONC. |
|---|---|---|---|---|---|---|---|
| Uranium | | Terbium | | Ruthenium | | Vanadium | 0.002 |
| Thorium | | Gadolinium | | Molybdenum | 0.003 | Titanium | 0.03 |
| Bismuth | | Europium | | Niobium | 0.002 | Scandium | ≤0.001 |
| Lead | 0.2 | Samarium | | Zirconium | 0.003 | Calcium | 1 |
| Thallium | | Neodymium | | Yttrium | <0.001 | Potassium | >11 |
| Mercury | NR | Praseodymium | | Strontium | 0.01 | Chlorine | 1 |
| Gold | | Cerium | | Rubidium | 0.003 | Sulfur | MC |
| Platinum | | Lanthanum | 0.04 | Bromine | 0.05 | Phosphorus | 0.1 |
| Iridium | | Barium | 0.006 | Selenium | 0.4 | Silicon | 6 |
| Osmium | | Cesium | <0.001 | Arsenic | <0.001 | Aluminum | 0.1 |
| Rhenium | | Iodine | 0.001 | Germanium | <0.001 | Magnesium | 0.4 |
| Tungsten | | Tellurium | 0.007 | Gallium | 0.02 | Sodium | MC |
| Tantalium | | Antimony | | Zinc | 2 | Fluorine | ≈0.2 |
| Hafnium | | Tin | 0.003 | Copper | 1 | Oxygen | NR |
| Lutetium | | Indium | STD | Nickel | 0.05 | Nitrogen | NR |
| Ytterbium | | Cadmium | | Cobalt | <0.001 | Carbon | NR |
| Thulium | | Silver | 0.08 | Iron | 0.4 | Boron | <0.001 |
| Erbium | | Palladium | | Manganese | 0.02 | Beryllium | |
| Holmium | | Rhodium | | Chromium | 0.02 | Lithium | 0.003 |
| Dysprosium | | | | | | Hydrogen | NR |

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

5-28
Approved: M Jacobs

# AAS ANALYSIS SHEET

**Contractor** Acurex

**Sample Site** COLT INDUSTRIES **Sample Acquisition Date** 4-24/25-80

**Type of Source** SPARK IGNITION ENGINE

**Test Number** **Sample ID Number**

**Sample Description**

**Original Sample Volume or Mass**

**Analyst Responsible** G. Nicoll **Date Analyzed** 7-9-80 **Time**

**Calculations and Report Reviewed By** G. Nicoll **Report Date**

| | As | Hg | Sb |
|---|---|---|---|
| Instrument Used | PE 460 | PE 460 | PE 460 |
| Wavelength Setting (nm) | 193.7 | 253.7 | 217.6 |
| Lamp Current (ma) | 8 watts | 6 | 20 |
| Fuel/Oxidizer Pressures (psi) | | | |
| PM Voltage (volts) | | | |
| Detection Limit ug/L | 10 | 1 | 3 |
| Sensitivity (abs. units/ppm/sample volume) | | | |
| High/Low Calibration Standards (ppm) | 0.050 | 0.050 | 0.100 |
| Sample Aliquot Volume (mL) | 0.02 | 25. | 0.02 |
| Dilution Factor | | | |
| Uncorrected Sample Aliquot Value (ppm) | | | |
| Blank Value (ppm) | | | |
| Corrected Sample Aliquot Value (ppm) | | | |
| Assigned Concentration* | | | |
| At Source Mass/Volume, $mg/m^3$ or μg/L | | | |

***Results:** PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank or baseline).

ACUREX Corporation
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 10, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 3 SPARK BASELINE

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (CUSTOMER) | Lube Hg | XAD Hg | 1 Imp Hg | 2&3 Hg | 2&3 As | 2&3 Sb | | | | |
| SAMPLE ID (LAB) | | | | | | | | | | |
| PARAMETER | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | UNITS |
| Blank | Less 1 | Less 1 | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Sample Aliquot | Less 1 | Less 1 | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Total Sample | | | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Total Sample | Less 0.1 | Less 0.1 | | | | | | | | ug/g |
| Total Sample | | Less 10 | Less 2 | Less 1 | Less 10 | Less 3 | | | | ug |
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ANALYST G. Nicoll
REVIEWER Greg Nicoll

Form EED-057 4/80

**ACUREX Corporation**
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 10, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 4 SPARK CONTROLLED NOx

| SAMPLE ID (CUSTOMER) | Lube Hg | XAD Hg | 1 Imp Hg | 2&3 Hg | 2&3 As | 2&3 Sb | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (LAB) | | | | | | | | | | |
| PARAMETER | | | | | | | | | | UNITS |
| Blank | Less 1 | Less 1 | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Sample Aliquot | Less 1 | Less 1 | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Total Sample | | | Less 1 | Less 1 | Less 10 | Less 3 | | | | ug/L |
| Total Sample | Less 0.1 | Less 0.1 | | | | | | | | ug/g |
| Total Sample | | Less 10 | Less 2 | Less 1 | Less 10 | Less 3 | | | | ug |
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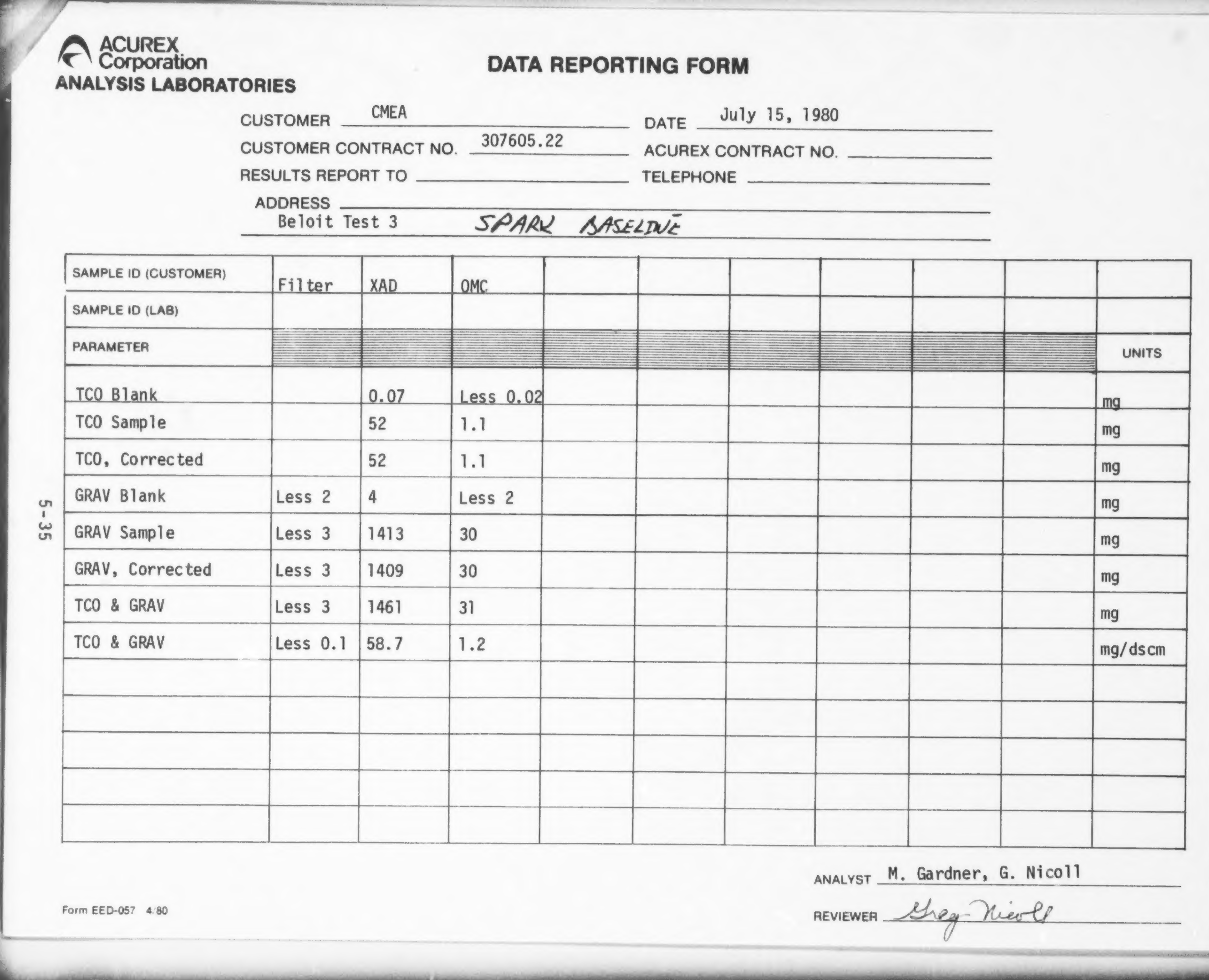
ANALYST G. Nicoll
REVIEWER Greg Nicoll

Form EED-057 4/80

## 5.4 TCO, GRAV, IR, AND GC/MS ANALYSES OF TOTAL SAMPLE EXTRACTS



**ACUREX Corporation**
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 15, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 3 SPARK BASELINE

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (CUSTOMER) | Filter | XAD | OMC | | | | | | | | |
| SAMPLE ID (LAB) | | | | | | | | | | | |
| PARAMETER | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | UNITS |
| TCO Blank | | 0.07 | Less 0.02 | | | | | | | | mg |
| TCO Sample | | 52 | 1.1 | | | | | | | | mg |
| TCO, Corrected | | 52 | 1.1 | | | | | | | | mg |
| GRAV Blank | Less 2 | 4 | Less 2 | | | | | | | | mg |
| GRAV Sample | Less 3 | 1413 | 30 | | | | | | | | mg |
| GRAV, Corrected | Less 3 | 1409 | 30 | | | | | | | | mg |
| TCO & GRAV | Less 3 | 1461 | 31 | | | | | | | | mg |
| TCO & GRAV | Less 0.1 | 58.7 | 1.2 | | | | | | | | mg/dscm |
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ANALYST M. Gardner, G. Nicoll
REVIEWER Greg Nicoll

Form EED-057 4/80

**IR REPORT**

**SAMPLE:** Filter Beloit Test 3 SPARK BASE LINE

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** XAD Beloit Test 3 SPARK BASE LINE

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 3575-3075 | W | O-H (COOH) | |
| 2905 | S | C-H Alkane | |
| 2845 | S | C-H Alkane | |
| 2750-2450 | W | O-H (COOH) | |
| 1725 | M | C=O (COOH) | |
| 1635 | W | C=C Alkene | |
| 1550 | W | $NO_2$ Alkane | |
| 1445 | W | C-H Alkane | |
| 1375 | W | C-H Alkane/$NO_2$ Alkane | |
| 1265 | W | C-O (COOH) | |

**IR REPORT**

**SAMPLE:** OMC Beloit Test 3 SPARK BASE LINE

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 3580-2980 | W | O-H (COOH) | |
| 2905 | S | C-H Alkane | |
| 2845 | S | C-H Alkane | |
| 2750-2450 | W | O-H (COOH) | |
| 1670 | S | C=O (COOH) | |
| 1445 | W | C-H Alkane | |

**ACUREX Corporation**
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 15, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 4 SPARK LOW-$NO_x$

| SAMPLE ID (CUSTOMER) | Filter | XAD | OMC | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (LAB) | | | | | | | | | | |
| PARAMETER | | | | | | | | | | UNITS |
| TCO Blank | | 0.07 | Less 0.02 | | | | | | | mg |
| TCO Sample | | 62 | 1.4 | | | | | | | mg |
| TCO, Corrected | | 62 | 1.4 | | | | | | | mg |
| GRAV Blank | Less 2 | 4 | Less 2 | | | | | | | mg |
| GRAV Sample | 54 | 519 | 16 | | | | | | | mg |
| GRAV, Corrected | 54 | 515 | 16 | | | | | | | mg |
| TCO & GRAV | 54 | 577 | 17 | | | | | | | mg |
| TCO & GRAV | 2.0 | 21.9 | 0.6 | | | | | | | mg/dscm |
| | | | | | | | | | | |
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ANALYST M. Gardner, G. Nicoll
REVIEWER Greg Nicoll

Form EED-057 4/80

**IR REPORT**

**SAMPLE:** Filter Beloit Test 4 SPARK Low $NO_x$

| Wave Number (cm$^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| 3575-3075 | W | O-H (COOH) |
| 2905 | S | C-H Alkane |
| 2848 | S | C-H Alkane |
| 2750-2450 | W | O-H (COOH) |
| 1725 | M | C=O (COOH) |
| 1445. | M | C-H Alkane |
| 1375 | W | C-H Alkane |

**IR REPORT**

**SAMPLE:** XAD Beloit Test 4 SPARK LOW NOx

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 3575-3075 | W | O-H (COOH) | |
| 2905 | S | C-H Alkane | |
| 2845 | S | C-H Alkane | |
| 2750-2450 | W | O-H (COOH) | |
| 1725 | M | C=O (COOH) | |
| 1635 | W | C=C Alkene | |
| 1550 | W | $NO_2$ Alkane | |
| 1445 | M | C-H Alkane | |
| 1375 | W | C-H Alkane/$NO_2$ Alkane | |
| 725 | W | C=C Alkene | |
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**IR REPORT**

**SAMPLE:** OMC Beloit Test 4

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 3580-2980 | W | O-H Alkane | |
| 2905 | S | C-H Alkane | |
| 2845 | S | C-H Alkane | |
| 2750-2450 | W | O-H (COOH) | |
| 1680 | M | C=O (COOH) | |
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## COMPOUNDS SOUGHT

Detection Limit in nanograms

| | | | |
|---|---|---|---|
| 8 | * 4-bromophenyl phenyl ether | 40 | * indeno(1,2,3-cd)pyrene |
| 1 | * bis (2-chloroisopropyl) ether | 2 | * pyrene |
| 2 | * bis (2-chloroethoxy) methane | 20 | 2,3,7,8-tetrachlorodibenzo-p-dioxin |
| 8 | * hexachlorobutadiene | 2 | * acenaphthene |
| 40 | * hexachlorocyclopentadiene | 100 | * benzidine |
| 1 | * isophorone | 8 | * 1,2,4-trichlorobenzene |
| 1 | * naphthalene | 8 | * hexachlorobenzene |
| 8 | * nitrobenzene | 8 | * hexachloroethane |
| 4 | * N-nitrosodiphenylamine | 3 | * bis(2-chloroethyl)ether |
| 40 | * N-nitrosodi-n-propylamine | 2 | * 2-chloronaphthalene |
| 3 | * bis (2-ethylhexyl) phthalate | 4 | * 1,2-dichlorobenzene |
| 3 | * butyl benzyl phthalate | 8 | * 1,3-dichlorobenzene |
| 1 | * di-n-butyl phthalate | 4 | * 1,4-dichlorobenzene |
| 2 | * di-n-octyl phthalate | 20 | * 3,3-dichlorobenzindine |
| 2 | * diethyl phthalate | 10 | * 2,4-dinitrotoluene |
| 2 | * dimethyl phthalate | 10 | * 2,6-dinitrotoluene |
| 5 | * benzo(a)anthracene | 1 | * 1,2-diphenylhydrazine (as azobenzene) |
| 7 | * benzo(a)pyrene | 2 | * fluoranthene |
| 8 | * 3,4-benzofluoranthene | 4 | * 4-chlorophenyl phenyl ether |
| 8 | * benzo(k)fluoranthene | 40 | anthanthrene |
| 5 | * chrysene | 40 | benzo(e)pyrene |
| 1 | * acenaphthylene | @ | dibenzo(a,H)pyrene |
| 1 | * anthracene | @ | dibenzo(a,i)pyrene |
| 40 | * benzo(ghi)perylene | 40 | dibenzo(c,g)carbozole |
| 2 | * fluorene | 40 | 7,12 dimethyl benz(a)anthracene |
| 1 | * phenanthrene | 40 | 3-methyl cholanthrene |
| 40 | * dibenzo(a,h)anthracene | 40 | perylene |
| | | 40 | Benzo(c)phenanthrene |

*Authenic standard ran

@Molecular weight too high for direct analysis by Base/Neutral run

**ACUREX Corporation**
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 21, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 3 24.9 dscm SPARK BASELINE

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (CUSTOMER) | Filter Bk | Filter | XAD Blank | XAD | OMC | | | | | |
| SAMPLE ID (LAB) | | | | | | | | | | |
| PARAMETER | | | | | | | | | | UNITS |
| Amount Injected | 2 | 2 | 2 | 1 | 2 | | | | | uL |
| Bis eth/hex phthalate* | Less 2 | 590 | 13 | 2600 | Less 20 | | | | | mg/L |
| Chrysene/Benz(a)anthr* | Less 3 | Less 3 | Less 3 | 10 | Less 3 | | | | | mg/L |
| Phenanthr/Anthracene* | Less 0.5 | Less 0.5 | Less 0.5 | 10 | 1 | | | | | mg/L |
| Bis eth/hex phthalate | | 29 | | 1100 | Less 0.9 | | | | | ug/dscm |
| Chrysene/Benz(a)anthr | | Less 0.1 | | 4 | Less 0.1 | | | | | ug/dscm |
| Phenanthr/Anthracene | | Less 0.02 | | 4 | 0.04 | | | | | ug/dscm |
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*Sample Aliquot

ANALYST
REVIEWER Greg Nicoll

Form EED-057 4/80

ACUREX Corporation
**ANALYSIS LABORATORIES**

# DATA REPORTING FORM

CUSTOMER CMEA
DATE July 21, 1980
CUSTOMER CONTRACT NO. 307605.22
ACUREX CONTRACT NO.
RESULTS REPORT TO
TELEPHONE
ADDRESS
Beloit Test 4 26.4 dscm SPARK LOW-NOx

| SAMPLE ID (CUSTOMER) | Filter Bk | Filter | XAD Blank | XAD | OMC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID (LAB) | | | | | | | | | | |
| PARAMETER | | | | | | | | | | UNITS |
| Amount injected | 2 | 1 | 2 | 1 | 2 | | | | | uL |
| Bis eth/hex phthalate* | Less 2 | Less 3 | 13 | Less 20 | Less 2 | | | | | mg/L |
| Chrysene/Benz(a)anthr* | Less 3 | Less 5 | Less 3 | Less 5 | Less 3 | | | | | mg/L |
| Phenanthr/Anthracene* | Less 0.5 | Less 1 | Less 0.5 | 8 | 0.7 | | | | | mg/L |
| Bis eth/hex phthalate | | Less 1 | | Less 8 | Less 0.08 | | | | | ug/dscm |
| Chrysene/Benz(a)anthr | | Less 2 | | Less 2 | Less 0.1 | | | | | ug/dscm |
| Phenanthr/Anthracene | | Less 0.4 | | 3 | 0.03 | | | | | ug/dscm |
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*Sample Aliquot

ANALYST
REVIEWER Greg Nicoll

Form EED-057 4/80

## 5.5 $C_1$ TO $C_6$ HYDROCARBON (GAS CHROMATOGRAPHY) DATA REDUCTION

Preceding page blank

## ORGANIC COMPOUNDS (bp < 100° C)

**Contractor** colt industries – Beloit wisconcin

**Sample Site** ______ **Sample Acquisition Date** 4-24-80 **Time** ______

**Type of Source** I C engine

**Test Number** 3 Baseline **Sample ID Number** 063 Chromatogram #8

**Sample Description** Flue gas

**Analyst Responsible** B. Daros / M. Chips **Date Analyzed** 5-20-80 **Time** ______

**Calculations and Report Reviewed By** Castaldini **Report Date** ______

### Workup

1. **Column Flow Rate (mL/min)** 40
2. **Recorder Speed** 1 cm/min
3. **Full Scale (mV)** 1 mv
4. **Column Pressure (psi)** 30
5. **Electrometer Set (A/mV)** $64 \times 10^{-12} / 8 \times 10^{-12}$
6. **Calibration Date** 5-20-80
7. **Sample Size (mL)** 1 ml
8. **Oven Temperature (°C)** 150°C
9. **Flame Flow Rates (mL/min):** $H_2$ 30 **Air** 300
10. **Attenuation** see #5
11. **Range** $10^{-12}$
12. **Observations** twin peak at 6.8/7.4 min is also present in cal gas bulB

**Results:** PPM value (in original sample) or I – interference; NC – not computed; NG – sample value below blank; ND – not detectable (< 2 σ blank or baseline).

| | Uncorrected Sum of Peak Areas | Blank Valve | Retention Time | Corrected Sum of Peak Areas | Conc. (%) | Sensitivity | High/Low Calibration Standards | Conc. (ppm) |
|---|---|---|---|---|---|---|---|---|
| $C_1$ | — | | .8 | — | | | | ND |
| $C_2$ | — | | 1.1 | — | | | | ND |
| $C_3$ | — | | 1.8 | — | | | | ND |
| $C_4$ | — | | 3.6 | — | | | | ND |
| $C_5$ | 616 | | 6.8/7.4 | 4928 | | | | 75.1 ± 7.5 |
| $C_6$ | | | | | | | | |
| $C_7$ | | | | | | | | |

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## ORGANIC COMPOUNDS (bp < 100° C)

**Contractor** Colt industries - Beloit wisconsin

**Sample Site** ____ **Sample Acquisition Date** 4-24-80 **Time** ____

**Type of Source** I C engine

**Test Number** 3 Baseline **Sample ID Number** 063 chromatogram #9

**Sample Description** Flue gas

**Analyst Responsible** B. Davos / M. Chips **Date Analyzed** 5-20-80 **Time** ____

**Calculations and Report Reviewed By** Castaldini **Report Date** ____

### Workup

1. **Column Flow Rate (mL/min)** 40
2. **Recorder Speed** 1 cm/min
3. **Full Scale (mV)** 1 mv
4. **Column Pressure (psi)** 30
5. **Electrometer Set (A/mV)** $8 \times 10^{-12}$
6. **Calibration Date** 5-20-80
7. **Sample Size (mL)** 1 ml
8. **Oven Temperature (°C)** 150°C
9. **Flame Flow Rates (mL/min):** $H_2$ 30 **Air** 300
10. **Attenuation** see #5
11. **Range** $10^{-12}$
12. **Observations** twin peak at 6.8/7.3 min is also present in cal gas BulB

**Results:** PPM value (in original sample) or I – interference; NC – not computed; NG – sample value below blank; ND – not detectable (< 2 σ blank or baseline).

| | Uncorrected Sum of Peak Areas | Blank Value | Retention Time | Corrected Sum of Peak Areas | Conc. (%) | Sensitivity | High/Low Calibration Standards | Conc. (ppm) |
|---|---|---|---|---|---|---|---|---|
| $\Sigma C_1$ | — | | .8 | — | | | | ND |
| $\Sigma C_2$ | — | | 1.1 | — | | | | ND |
| $\Sigma C_3$ | — | | 1.8 | — | | | | ND |
| $\Sigma C_4$ | — | | 3.6 | — | | | | ND |
| $\Sigma C_5$ | 684 | | 6.8/7.3 | 5472 | | | | 81.2 ± 8.1 |
| $\Sigma C_6$ | | | | | | | | |
| $\Sigma C_7$ | | | | | | | | |

A-9

# ORGANIC COMPOUNDS (bp < 100° C)

Contractor Colt industries – Beloit wisconcin

Sample Site ______ Sample Acquisition Date 4-25-80 Time ______

Type of Source I C Engine

Test Number 4 Low-$NO_x$ Sample ID Number 077 chromatogram # 4

Sample Description Flue gas

Analyst Responsible B. Davos / M. Chips Date Analyzed 5-20-80 Time ______

Calculations and Report Reviewed By Castaldini Report Date ______

## Workup

1. Column Flow Rate (mL/min) 40
2. Recorder Speed 2 → 1 cm/min
3. Full Scale (mV) 1 mv
4. Column Pressure (psi) 30 psi
5. Electrometer Set (A/mV) $8 \times 10^{-12}$
6. Calibration Date 5-20-80
7. Sample Size (mL) 1 ml
8. Oven Temperature (°C) 150°C
9. Flame Flow Rates (mL/min): $H_2$ 30 Air 300
10. Attenuation see #5
11. Range $10^{-12}$
12. Observations twin peak (artifact) at RT = 6.7/7.2

**Results:** PPM value (in original sample) or I – interference; NC – not computed; NG – sample value below blank; ND – not detectable (<2 σ blank or baseline).

| | Uncorrected Sum of Peak Areas | Blank Valve | Retention Time min. | Corrected Sum of Peak Areas | Conc. (%) | Sensitivity | High/Low Calibration Standards | ±10% Conc. (ppm) |
|---|---|---|---|---|---|---|---|---|
| $IC_1$ | 11 | | .8 | 88 | | | | 15.1 |
| $IC_2$ | 28 | | 1.1 | 224 | | | | 14.6 |
| $IC_3$ | 88 | | 1.8 | 704 | | | | 15.6 |
| $IC_4$ | 73 | | 4.0 | 584 | | | | 15.2 |
| $IC_5$ | 128 | | 9.5 | 1024 | | | | 15.6 |
| $IC_6$ | – | | (≈24) | – | | | | 15.9 |
| $IC_7$ | | | | | | | | |

A-9

# ORGANIC COMPOUNDS (bp < 100° C)

**Contractor** Colt industries - Beloit wisconcin

**Sample Site** ______ **Sample Acquisition Date** 4-25-80 **Time** ______

**Type of Source** IC engine

**Test Number** 4 Low $NO_x$ **Sample ID Number** 074 chromatogram #6

**Sample Description** Flue gas

**Analyst Responsible** B. Davos / M. Chips **Date Analyzed** 5-20-80 **Time** ______

**Calculations and Report Reviewed By** Castaldini **Report Date** ______

## Workup

1. **Column Flow Rate (mL/min)** 40
2. **Recorder Speed** 1 cm/min
3. **Full Scale (mV)** 1 mv
4. **Column Pressure (psi)** 30
5. **Electrometer Set (A/mV)** $8 \times 10^{-12}$
6. **Calibration Date** 5-20-80
7. **Sample Size (mL)** 1 ml
8. **Oven Temperature (°C)** ______
9. **Flame Flow Rates (mL/min):** $N_2$ 30 **Air** 300
10. **Attenuation** see #5
11. **Range** $10^{-12}$
12. **Observations** $C_5$ Peak also present in Calibration Bulb (Artifact?)

**Results:** PPM value (in original sample) or I – interference; NC – not computed; NG – sample value below blank; ND – not detectable (< 2 σ blank or baseline).

|  | Uncorrected Sum of Peak Areas | Blank Valve | Retention Time | Corrected Sum of Peak Areas | Conc. (%) | Sensitivity | High/Low Calibration Standards | Conc. (ppm) |
|---|---|---|---|---|---|---|---|---|
| $C_1$ | — |  | .8 | — |  |  |  | ND |
| $C_2$ | — |  | 1.1 | — |  |  |  | ND |
| $C_3$ | 20 |  | 1.8 | 160 |  |  |  | 3.5 ± 1.6 |
| $C_4$ | 25 |  | 3.6 | 200 |  |  |  | 5.2 ± 1.5 |
| $C_5$ | 603 |  | 7.3 | 4824 |  |  |  | 73.5 ± 7.4 |
| $C_6$ |  |  |  |  |  |  |  |  |
| $C_7$ |  |  |  |  |  |  |  |  |

# ORGANIC COMPOUNDS (bp <100° C)

**Contractor** Colt industries - Beloit wisconcin

**Sample Site** ____ **Sample Acquisition Date** 4-25-80 **Time** ____

**Type of Source** I C engine

**Test Number** 4 Low $NO_x$ **Sample ID Number** 074 chromatogram #7

**Sample Description** Flue gas

**Analyst Responsible** B. Davos / M. Chips **Date Analyzed** 5-20-80 **Time** ____

**Calculations and Report Reviewed By** Castaldini **Report Date** ____

## Workup

1. **Column Flow Rate (mL/min)** 40
2. **Recorder Speed** 1 cm/min
3. **Full Scale (mV)** 1 mv
4. **Column Pressure (psi)** 30
5. **Electrometer Set (A/mV)** $8 \times 10^{-12} / 64 \times 10^{-12}$
6. **Calibration Date** 5-20-80
7. **Sample Size (mL)** 1 ml
8. **Oven Temperature (°C)** 150°C
9. **Flame Flow Rates (mL/min):** $H_2$ 30 **Air** 300
10. **Attenuation** see #5
11. **Range** $10^{-12}$
12. **Observations** ____

**Results:** PPM value (in original sample) or I – interference; NC – not computed; NG – sample value below blank; ND – not detectable (<2 σ blank or baseline).

| | Uncorrected Sum of Peak Areas | Blank Valve | Retention Time | Corrected Sum of Peak Areas | Conc. (%) | Sensitivity | High/Low Calibration Standards | Conc. (ppm) |
|---|---|---|---|---|---|---|---|---|
| $IC_1$ | 52 | | .8 | 3328 | | $64 \times 10^{-12}$ | | 571 ± 57 |
| $IC_2$ | 72 | | 1.1 | 576 | | $8 \times 10^{-12}$ | | 37,5 ± 3.8 |
| $IC_3$ | 16 | | 1.8 | 128 | | ↓ | | 2,8 ± 1.6 |
| $IC_4$ | 17 | | 3.6 | 136 | | | | 3,5 ± 1.5 |
| $IC_5$ | 654 | | 7.1 | 5232 | | | | 79.7 ± 8.0 |
| $IC_6$ | | | | | | | | |
| $IC_7$ | | | | | | | | |

## 5.6 LIQUID CHROMATOGRAPHY OF TOTAL SAMPLE EXTRACTS WITH IR SPECTRA OF LC FRACTIONS

SAMPLE: Beloit 3 XAD #1536

| | TCO mg | GRAV mg | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|
| Total Sample[1] | 52 | 1410 | 1460 | 59 |
| Taken for LC[2] | 3.5 | 96 | 100 | 4.0 |
| Recovered[3] | 1.5 | 17 | 18 | 0.72 |

| Fraction | TCO in mg | | | | GRAV in mg | | | | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|---|---|---|---|---|---|
| | Found in Fraction | Blank | Corrected | Total[4] | Found in Fraction | Blank | Corrected | Total[4] | | |
| 1 | 0.45 | < 0.02 | 0.45 | 6.6 | 8 | < 1 | 8 | 120 | 130 | 5.2 |
| 2 | 0.68 | < 0.01 | 0.68 | 10 | < 0.8 | < 0.8 | < 0.8 | <10 | 10 | 0.40 |
| 3 | 0.24 | < 0.01 | 0.24 | 3.5 | 2.6 | < 0.8 | 2.6 | 38 | 42 | 1.7 |
| 4 | 0.08 | < 0.01 | 0.08 | 1 | 2.2 | 1.2 | 1.0 | 15 | 16 | 0.64 |
| 5 | < 0.01 | < 0.01 | <0.01 | < 0.1 | 1.6 | < 0.8 | 1.6 | 24 | 24 | 0.96 |
| 6 | 0.03 | < 0.01 | 0.03 | 0.4 | 2.0 | < 0.8 | 2.0 | 29 | 29 | 1.2 |
| 7 | < 0.01 | < 0.01 | <0.01 | < 0.1 | 1.4 | < 0.8 | 1.4 | 21 | 21 | 0.84 |
| Sum | 1.5 | < 0.08 | 1.5 | 22 | 18 | < 6 | 17 | 250 | 270 | 11 |

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample

**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F1

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |

**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F2

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F3

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F4

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F5

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F6

| Wave Number (cm$^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |
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**IR REPORT**

**SAMPLE:** Beloit XAD Blank 1535 F7

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F1

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Aliphatic hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F2

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | | |
| | | No Peaks | |

**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F3

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F4

| Wave Number (cm$^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |
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**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F5

| Wave Number $(cm^{-1})$ | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |
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**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F6

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit 3 XAD 1536 F7

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**SAMPLE:** Beloit 4 Front Half #1523 SPARK LOW NOX

| | TCO mg | GRAV mg | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|
| **Total Sample**[1] | NA | 54 | 54 | 2.0 |
| **Taken for LC**[2] | - | 28 | 28 | 1.1 |
| **Recovered**[3] | - | 23 | 23 | 0.87 |

| Fraction | TCO in mg | | | | GRAV in mg | | | | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|---|---|---|---|---|---|
| | Found in Fraction | Blank | Corrected | Total[4] | Found in Fraction | Blank | Corrected | Total[4] | | |
| 1 | | | | | 10 | <1 | 10 | 20 | 20 | 0.76 |
| 2 | | | | | 1.2 | <0.8 | 1.2 | 2 | 2 | 0.08 |
| 3 | | | | | 3.8 | <0.8 | 3.8 | 7 | 7 | 0.3 |
| 4 | | | | | 1.6 | <0.8 | 1.6 | 3 | 3 | 0.1 |
| 5 | | | | | 1.6 | <0.8 | 1.6 | 3 | 3 | 0.1 |
| 6 | | | | | 3.4 | <0.8 | 3.4 | 7 | 7 | 0.3 |
| 7 | | | | | 1.6 | <0.8 | 1.6 | 3 | 3 | 0.1 |
| Sum | | | | | 23 | <6 | 23 | 45 | 45 | 1.7 |

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample

**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F1

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F2

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |

**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F3

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F4

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F5

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |

**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F6

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit Filter Blank 1521 F7

| Wave Number ($cm^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |

**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 Fl

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Aliphatic hydrocarbons | |
| 2860 | s | CH Aliphatic Hydrocarbons | |
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**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 F2

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Aliphatic hydrocarbons | |
| 2840 | s | CH Aliphatic hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 F3

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 F4

| Wave Number (cm⁻¹) | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Hydrocarbons | |
| 2840 | s | CH Hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 F5

| Wave Number (cm$^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |
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**IR REPORT**

**SAMPLE:** Beloit 4 1523 F6 Front Half

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit 4 Front Half 1523 F7

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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SAMPLE: Beloit 4 XAD #1537

| | TCO mg | GRAV mg | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|
| Total Sample[1] | 62 | 520 | 580 | 22 |
| Taken for LC[2] | 11 | 88 | 99 | 3.8 |
| Recovered[3] | 4 | 25 | 29 | 1.1 |

| Fraction | TCO in mg | | | | GRAV in mg | | | | TCO + GRAV Total mg | Concentration mg/dscm |
|---|---|---|---|---|---|---|---|---|---|---|
| | Found in Fraction | Blank | Corrected | Total[4] | Found in Fraction | Blank | Corrected | Total[4] | | |
| 1 | 3.3 | <0.02 | 3.3 | 19 | <1 | <1 | <1 | <6 | 19 | 0.72 |
| 2 | 0.17 | <0.01 | 0.17 | 1.0 | 3.6 | <0.8 | 3.6 | 21 | 22 | 0.83 |
| 3 | 0.49 | <0.01 | 0.49 | 2.9 | 5.0 | <0.8 | 5.0 | 29 | 32 | 1.2 |
| 4 | 0.08 | <0.01 | 0.08 | 0.5 | 4.4 | 1.2 | 3.2 | 19 | 20 | 0.76 |
| 5 | <0.01 | <0.01 | <0.01 | <0.06 | 2.4 | <0.8 | 2.4 | 14 | 14 | 0.53 |
| 6 | <0.01 | <0.01 | <0.01 | <0.06 | 7.2 | <0.8 | 7.2 | 42 | 42 | 1.6 |
| 7 | <0.01 | <0.01 | <0.01 | <0.06 | 3.6 | <0.8 | 3.6 | 21 | 21 | 0.80 |
| Sum | 4.0 | <0.08 | 4.0 | 24 | 26 | <6 | 25 | 150 | 170 | 6.4 |

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample

**IR REPORT**

**SAMPLE:** Beloit 4 XAD 1537 F1

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Aliphatic hydrocarbons | |
| 2840 | s | CH Aliphatic hydrocarbons | |
| 1640 | w | C=C Aliphatic hydrocarbons | |
| 1440 | m | CH Aliphatic hydrocarbons | |
| 1370 | m | CH Aliphatic hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 4 XAD 1537 F2

| Wave Number ($cm^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |

**IR REPORT**

**SAMPLE:** Beloit 4 XAD 1537 F3

| Wave Number (cm$^{-1}$) | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Hydrocarbons | |
| 2840 | s | CH Hydrocarbons | |

**IR REPORT**

**SAMPLE:** Beloit 4 XAD 1537 F4

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| | | No Peaks | |
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**IR REPORT**

**SAMPLE:** Beloit 4 XAD F5

| Wave Number $(cm^{-1})$ | Intensity | Assignment | Comments |
|---|---|---|---|
| 2920 | s | CH Hydrocarbons | |
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**IR REPORT**

**SAMPLE:** Beloit 4 XAD F6

| Wave Number ($cm^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |

**IR REPORT**

**SAMPLE:** Beloit 4 XAD F7

| Wave Number (cm$^{-1}$) | Intensity | Assignment Comments |
|---|---|---|
| | | No Peaks |

## 5.7 LOW RESOLUTION MASS SPECTROMETRY OF LC FRACTIONS

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ACUREX Corporation

Energy & Environmental Division

CMEA/ACUREX

October 8, 1981
Acurex ID#: A81-08-022
Client P.O. #: 307605

Samples: 45 extracts from previous work

The above reference samples were analyzed by direct probe mass spectrometry. Searches have been made for classes of compounds most likely to be found in the various LC fractions, according to procedures described in the "IERL-RTP Procedures Manual: Level 1 Environmental Assessment". The following fragment ions used for search are given below:

| Compound Class | Fragment ions ($m/e^-$) |
|---|---|
| Aliphatic hydrocarbons | 57,71,85 |
| Halogenated aliphatics | 63,65 |
| Polycyclic aromatics | 178,202,228,252 |
| Halogenated ethers | 63,65,73 |
| Alcohols | 75,89,103 |
| Phenols | 51,77,94 |
| Halogenated phenols | 162,196 |
| Nitrophenols | 139 |
| Phthalate esters | 149,167 |
| Amines | 84,98 |
| Nitrosamines | 44,58 |
| N-heterocyclics | 167,193 |
| Mercaptans | 47,61 |
| Sulfides | 75,89,103 |
| Benzothiophenes | 134 |
| Carboxylic acids | 60,73 |
| Carboxylic acids esters | 74,87 |

The various classes of compounds identified in each fraction are given on the attached data sheets. Classes of compounds identified include phenols, carboxylic acids, mercaptans, and esters (include phthalates). There was a background of aliphatic hydrocarbons throughout the analyses.

To test the analysis procedure, a standard mixture containing ethers, amines, polycyclic aromatic hydrocarbons, nitrosamines, phenols, etc., was analysed under identical conditions as the samples. Losses of the very volatile compounds such as naphthalene, bis-chloro ethyl ether, low molecular weight nitrosamines were observed, however the higher molecular weight compounds in a particular class were recovered.

Prepared by: Greg Nicoll
Greg Nicoll
Program Director

Approved by: Viorica Lopez Avila
Viorica Lopez-Avila, Ph.D.
Technical Director

GN/VLA:es

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**LRMS REPORT**

**SAMPLE:** 1536 F1 Beloit 3 XAD SPARK BASELINE

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 1 | Aliphatic hydrocarbons | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F2 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F3 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
|  | None found |  |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F4 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F5 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 10 | Phenols | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F6 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1536 F7 Beloit 3 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1523 Fl Beloit 4 Front half SPARK LOW NOX

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 1 | Aliphatic hydrocarbons | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1523 F2+3 Beloit 4 Front half

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1523 F4+5 Beloit 4 Front half

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1523 F6+7 Beloit 4 Front half

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 Fl Beloit 4 XAD SPARK LOW $NO_x$

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 1 | Aliphatic hydrocarbon | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F2 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F3 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F4 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| | None found | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F5 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 10 | Mercaptans | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F6 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 10 | Phenols | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
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**Other**

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**LRMS REPORT**

**SAMPLE:** 1537 F7 Beloit 4 XAD

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 10 | Carboxylic acids | |
| 1 | Phenols | |
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**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
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**Other**

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Acorn Park
Cambridge, Massachusetts 02140
617 864-5770 Telex 921436

Arthur D. Little, Inc.

July 8, 1982

Dr. Larry Waterland
M2S-2260
Accurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Dear Larry: 1-7641

We have completed the batch inlet LRMS analysis of your ten Level 1 samples. The data obtained in the analysis of these samples is reported on the enclosed, standard EPA Level 1 LRMS report forms. The intensity levels are reported for this (batch) analysis only, as though it were the complete LRMS analysis. Presumably you will integrate the data from these analyses with your own direct probe LRMS analysis of the same samples.

We have reported the "sample" content of the samples as though the solvent(s) were not present; a component reported as intensity 100 is a major component of the non-solvent portion of the spectrum; one as intensity 10 when it is present and identifiable in the non-solvent portion of the spectrum, and so on. Intensity level 1 components appeared to be present in some of the samples, but were not specifically identifiable. When they occur they are included in the unclassified category.

All samples were analyzed by direct injection of 4 μL of sample into the three liter glass inlet of the mass spectrometer. The mass spectrometer was operated in the electron impact ionization mode, at 70 eV. Low energy ionization was not used due to the low level of sample material as compared to the solvent content of the sample. Instrument blanks were obtained by direct injection of 4 μL of spectra grade methylene chloride. One sample (AC009) was

Brussels Paris Tokyo
Houston Rio de Janeiro Toronto
London San Francisco Washington
Madrid São Paulo Wiesbaden

concentrated 3X and given an additional direct injection analysis. This was done only to clarify some spectral ambiguities. The reported data is from the unconcentrated initial analysis.

If you have any questions about any of this work, please feel free to call me.

Yours Truly,

James L. Stauffer

/laf

enclosures

**LRMS REPORT**

**SAMPLE:** Beloit 4 XAD 1537 LCl (AC002)

**Major Categories**

| Intensity | Category | MW Range |
|---|---|---|
| 100 | Fused alternate/nonalternate hydrocarbons | 128 - 141 |
| 100 | Aliphatic Hydrocarbons | — |
| 10 | Aromatic Hydrocarbons | - |
| 10 | Unclassified | 94 |
| | | |
| | | |

**Sub-Categories, Specific Compounds**

| Intensity | Category | m/e | Composition |
|---|---|---|---|
| 100 | Naphthalene + alkyls | 94-142 | $C_{10}H_8$ - $C_{11}H_{10}$ |
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**Other**

## 5.8 BIOASSAY ANALYSIS REPORT

cc: Brent Heggin [illegible]

Litton **BIONETICS** 5516 Nicholson Lane, Kensington, Maryland 20795 301 881-5600 • Telex 89-8369

December 10, 1980

RECEIVED
[illegible] 1980
ACUREX

Mr. Roy Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Dear Mr. Belletto:

Enclosed are five copies of the final reports for the compound sample #1452 submitted for evaluation in the Ames/Salmonella and the In Vivo Rodent Quantal Toxicity Assays. All studies were conducted and evaluated under EPA Level 1 guidelines. The final reports have been reviewed by the Litton Bionetics Quality Assurance Unit to ensure compliance with GLP regulations. These final reports supersede the two draft reports sent on December 3, 1980. There are no significant changes between the draft and final versions of the reports.

If you have any questions or comments concerning the reports, please feel free to contact me at (301)881-5600, extension 527. I hope we may be of service to you in the future.

Sincerely,

David J. Brusick

David J. Brusick, Ph.D.
Director
Department of Genetics
and Cell Biology

DJB/mg

Enclosures: 5394 - Ames
5394 - Rodent Quantal

## BIOASSAY SUMMARY TABLE

Technical Directive or Project No. LBI Project Number 20933

Contract No. Acurex Subcontract RB59178A, Release Number 1

| | Health Effects Tests | | | | Ecological Effects Tests | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Aquatic | | | | | | Terrestrial | | | |
| | | | | | Fresh Water | | | Marine | | | | | | |
| Sample Identification | AMES Salmonella* | RAM Cytotoxicity | CHO Cytotoxicity | Rodent Toxicity | Fish | Invertebrate | Algal | Fish | Invertebrate | Algal | Plant Stress Ethylene | Root Elongation | Insect Toxicity | Notes |
| 1536 (CMEA Beloit | H | | H/M | | | | | | | | | | | |
| 3 XAD Extract) | | | | | | | | | | | | | | |
| 1537 (CMEA Beloit | M | | H/M | | | | | | | | | | | |
| 4 XAD Extract) | | | | | | | | | | | | | | |

ND = No Detectable Toxicity
L = Low Toxicity
M = Moderate Toxicity
H = High Toxicity

* Evaluation of Ames *Salmonella* test is based upon mutagenicity and not toxicity.

# DEFINITION OF TOXICITY CATEGORIES FOR HEALTH EFFECTS ASSAYS

| Assay[a] | Activity Measured[b] | Sample Type[c] | MAD[d] | Units | Range of Concentration or Dosage | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | High | Moderate | Low | Not Detectable (ND) |
| Ames | MEC (mutagenesis) | S | 5 | mg/plate | <0.05 | 0.05-0.5 | 0.5-5 | ND at >5 |
| | | AL,NAL | 200 | µl/plate | <2 | 2-20 | 20-200 | ND at >200 |
| | | E | 5000 | L/plate | <50 | 50-500 | 500-5000 | ND at >5000 |
| RAM | EC$_{50}$ (lethality) | S | 1 | mg/ml | <0.01 | 0.01-0.1 | 0.1-1 | ND at >1 |
| | | AL | 600 | µl/ml | <6 | 6-60 | 60-600 | ND at >600 |
| | | NAL | 20 | µl/ml | <0.2 | 0.2-2 | 2-20 | ND at >20 |
| | | E | 1000 | L/ml | <10 | 10-100 | 100-1000 | ND at >1000 |
| CHO | EC$_{50}$ (lethality) | S | 1 | mg/ml | <0.01 | 0.01-0.1 | 0.1-1 | ND at >1 |
| | | AL | 600 | µl/ml | <6 | 6-60 | 60-600 | ND at >600 |
| | | NAL | 20 | µl/ml | <0.2 | 0.2-2 | 2-20 | ND at >20 |
| | | E | 1000 | L/ml | <10 | 10-100 | 100-1000 | ND at >1000 |
| WAT | LD$_{50}$ (lethality and toxic signs) | S | 5 | gm/kg | <0.05 | 0.05-0.5 | 0.5-5 | ND at >5 |
| | | AL,NAL | 5 | ml/kg | <0.05 | 0.05-0.5 | 0.5-5 | ND at >5 |

[a] Standard test abbreviations are as follows:

Ames: Ames *Salmonella*/microsome mutagenesis assay
RAM: Rabbit alveolar macrophage cytotoxicity assay
CHO: Rodent cell clonal toxicity assay
WAT: Acute *in vivo* test in rodents (whole animal test)

[b] Standard abbreviations for measured endpoints are as follows:

MEC: Minimum effective concentration
EC$_{50}$: Calculated concentration expected to produce effect in 50 percent of population
LD$_{50}$: Calculated dose expected to kill 50 percent of population

[c] S = Solid, AL = Aqueous liquid, NAL = Nonaqueous liquid, E = Extract and/or concentrate of unknown organic content (use equivalent volume of SASS train gas)

[d] MAD = Maximum applicable dose

## TABLE

## HEALTH EFFECTS CRITICAL DATA SUMMARY FORM[a]

**Contract No.** Acurex Subcontract RB59178A, Release 1 **Technical Directive or Project No.** LBI Project No. 20933 **Site Sampled** Beloit

| Sample Identification | Ames Mutagenicity [MEC][b] | CHO Clonal Toxicity [$EC_{50}$][c] | RAM Cytotoxicity [EC50][c] | | | | Rodent Toxicity | |
|---|---|---|---|---|---|---|---|---|
| | | | Viability | Viability Index | ATP | ATP/Per $10^6$ Cells | $LD_{50}$[d] | Toxic Signs[e] |
| 1536 (CMEA Beloit 3 XAD | 22.4 μg | 10.1 μg | | | | | | |
| Extract) | | | | | | | | |
| 1537 (CMEA Beloit 4 XAD | 54.4 μg | 9.35 μg | | | | | | |
| Extract | | | | | | | | |
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[a] The assays, observed parameters and evaluation criteria are presented in IERL-RTP Procedures Manual; Level 1 Environmental Assessment Biological Tests, [EPA Contract No. 68-02-2681, Litton Bionetics, Inc., Kensington, Md., September 1980, in press.]

[b] MEC: Minimum Effective Concentration - Lowest concentration for any tester strain giving a mutagenic response.

[c] $EC_{50}$: Effective concentration that reduces the observed parameter to 50 percent of the appropriate negative control.

[d] $LD_{50}$: The dose lethal to 50 percent of treated animals.

[e] Toxic signs are identified in a numbered list in the Level 1 manual. Only the number is reported here.

LBI-0798 1/81